AP Environmental Science in Milton High School

by

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A Research Project
Submitted in partial fulfillment of
the requirements for the degree of

MASTER OF SCIENCE

in

Natural Resources-Environmental Education for Teachers
College of Natural Resources

UNIVERSITY OF WISCONSIN
Stevens Point, Wisconsin

November 2007
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ABSTRACT

The duration of this project was one year. In preparation for the 2006 school year research was done to determine what qualifications were needed and what topics were covered by an Advanced Placement Environmental Science Test. The goal of this research was to determine if Milton High School had a need and what avenues would have to be followed to add an AP Environmental Science class. After the school year began interviews were conducted with people at Milton High School and with one person at the Wisconsin Department of Public Instruction. Upon conclusion of the interviews it was decided that Advanced Placement Environmental Science curriculum should be added to an already existing class at this period in time. Curriculum was then compiled to deal with topics that were already being taught in the Wildlife and Natural Resources class. The curriculum was updated at a higher level of thinking as to meet the demands of an AP Environmental Science Class. Curriculum was compiled from many sources and then aligned with the AP Environmental Science topics. The result would be that if a student felt that after completing this class along with other classes they have completed they would have the opportunity to take the AP Environmental Science Exam.
ACKNOWLEDGEMENTS

I would like to thank all of the people that took time out of their schedule to let me interview them. Without their input this project would have never taken place. Their commitment to education shows when they listen and are open minded to new ideas. I would also like to thank my advisor Dr. Wilke for all of the time he spent revising my project and providing ideas and concerns to a young teacher trying to improve himself. His flexibility and expertise was greatly appreciated.
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Chapter I

Problem:

The purpose of this project is to implement a new class into the Milton high school where at the end of the class the students will take the AP Environmental Science Exam.

Sub problems

1. What is the process of adding a new course at Milton High School?
2. What does the AP Environmental Science exam offer students who pass the exam?
3. Who are the key players involved in adding an AP environmental science class to the Milton High School curriculum?
4. What curriculum is there that will help teach this course and prepare students for the exam?

Delimitation

1. The goal will be not to add new staff to the school.
2. A new course will not repeat curriculum offered in other Milton High School classes.
Definition of Terms

1. Milton School District- The students, faculty, and staff that are involved with the education of the students who attend Milton East Elementary, Milton West Elementary, Consolidated Elementary, Northside Intermediate, Milton Middle School, and Milton High School. The district is located in south central Wisconsin. The town is near Janesville Wisconsin and includes students from the town of Janesville north of Hwy 14.

2. Milton High School- The school consists of 948 students this 2006-2007 school year with programs in Agriculture, Technology Education, Business education, FACE, to supplement the core areas of instruction. The building is older with two gyms and very successful athletic programs as of the last few years. The school has a guidance department along with one principal, one vice principal, an athletic director, and a dean of students.

3. AP Environmental Science Exam- National Exam offered to high school juniors and senior that have exemplary knowledge in the area of environmental science. Students who receive a score of 3-5 (on a 5 point scale) receive college credit for the class at almost all colleges and universities.

4. New Class- The class that will be added to the agricultural program to prepare students to take the AP Environmental Science Exam.

5. Environmental Science- Environmental science is the science of the interactions between the physical, chemical, and biological components of the environment,
including their effects on all types of organisms and often includes human impact on the environment.

6. AP- Advanced Placement, A course and test designed at the college level for high schools students.

7. DPI- Department of Public Instruction, a governmental organization that regulates and assists the educational process in Wisconsin.

8. Success rate- The percentage of students that are able to pass an AP Exam.

Assumptions

1. The school district will continue to grow.

2. The number of students is increasing which means there will be more interests that students have.

3. The school district strives to provide opportunities for students to excel.

4. The cost of adding this class would be minimal.

5. The instructor of this class will be certified in Agricultural Education, Biology, and Environmental Science.

6. Students will have to meet the prerequisites to be able to participate in the class.

7. The class will only affect a small number of students (10-20 students).
Importance

The Milton school district is a growing community with many students entering the district. The more students a district has the wider variety of interests that students have. The Advanced Placement program set up in the United States is a growing program. In the last decade there has been an increase in high school seniors taking an Advanced Placement Exams from 10% to 14%. Wisconsin has followed this trend and the success rate of the state’s students has been 10% higher than the nation’s success rate. Cavanagh’s study also stated that high school seniors that take and pass an Advanced Placement exam have a far greater chance of making it through college (Cavanagh, 2006). In the Milton School District the Advanced Placement Environmental Science exam would give students another opportunity to participate in the Advanced Placement program.
Chapter II:

Literature Review

Introduction: Environmental education has had increased significance in the world since 1977 when the Tbilisi Intergovernmental Conference on Environmental Education published a declaration explaining its importance. This was one of the first times a group of people from around the world put into writing the importance of teaching people about the importance of the environment (WDPI 1985).

Environmental education has grown since the 1970’s. Many high schools across the state are offering an AP Environmental Science class and exam. The exam offers college credit at almost all accredited colleges and universities to students that pass the exam.

AP Environmental Science Exam: The AP Environmental Science Exam along with all other AP Exams are gaining in popularity nation wide. More AP classes and exams are being offered to meet the demand from more students who are going to college (Cavanagh, 2006). School districts are offering more AP classes to students so that they have the ability to go to college with credits already earned through the AP program.

Students who take AP Exams are also more likely to succeed in college (Mathews, 2006). Mathew’s study states that students who are introduced to college level classes in high school are more likely to succeed in college because they have more experience with the type of learning they will experience in college. This relates to why school districts are offering more AP exams to students.
The AP Environmental Science Exam covers many topics of instruction including science is a process, energy, natural systems; humans alter systems, environmental problems, and sustainability (www.collegeboard.com). These topics are important and can be used to teach many other ideas and skills. Upper level ideas are incorporated into these topics to make high school students think at a college level.

**Environmental Science Curriculum:** Teaching high school students appropriate information in an appropriate way is a challenge for any educator. Jacobsen (2006) states that high school students are being neglected in their environmental education instruction by many schools. Advanced placement environmental science classes are usually a minimum of a year to ensure that all of the topics are covered thoroughly. Jacobsen states that by the time a student reaches high school they can comprehend ideas and think at a higher level by that age. She also states that educators are not challenging students enough to meet their newly developed minds. Many environmental and agricultural educators and their programs are being eliminated in California (Aschwanden, 2005). Eliminating environmental and agriculture programs affects the quality of education that a school gives students.

Despite the program cuts in California, there are still many good examples of educators who are doing a great job with AP environmental science classes. They are challenging students and helping them learn to make decisions on their own after they have gathered information. One example of this is the Visalia School (www2.Visalia.k12.ca.us).
Addition of a new class at Milton High School: There is a process that must be completed to add a new class at Milton High School. First, approval from Bob Johnson, the other agriculture teacher in my department is needed. If Mr. Johnson does not support the idea then we will have a divided front with the administration. After Mr. Johnson approves the class then it is my job to convince the administration, including principal Randy Refsland that the class is needed. Cindy Drury also has to approve the class. She is the head guidance counselor. After the class is approved the proposed curriculum will need to be provided to Randy Bartels our curriculum director.

Summary: Environmental education should be an important part of our school curriculum and environmental literacy is needed to assure our continued existence as part of the earth system. All students even when they are in high school should be exposed to environmental education and offered more opportunities to learn about the world around them and how to interact in that world.
Chapter III:

Methods

The methods used to address each of the sub problems are described in this chapter.

Sub-problem- What is the process of adding a new course at Milton High School?

The answers to the following questions are needed before the start of school this year, September 2006 (this is when I did this). The questions are:

1. What is the procedure to implement a new class at Milton High School?
2. What is the timeline for the paperwork that has to be done for the approval and implementation of a new class?
3. What curriculum and paper work needs to be done for the class?

It is necessary to know the answers to these questions so that no dates are missed which will automatically nullify a new class proposal. It is also necessary to know the process to organize and prioritize a proposal for the administration.

Sub-problem- What does the AP Environmental Science exam offer students who pass the exam?

The answers to the following questions need to be obtained before the start of the 2006 school year.

1. How many schools offer an AP Environmental Science class?
2. What kind of credit do students receive for passing the AP exam?
3. What topics of study does the AP Environmental Science exam cover?
4. What age do the students have to be to take the test?

The answers to these questions will be necessary to promote the class to the administration and school board.

Sub-problem- Who are the key players involved in adding an AP environmental science class to the Milton High School curriculum?

The answers to the following questions need to be compiled before a proposal can be made to offer a new class.

1. Who are the people that influence and make decisions on whether or not a class can be offered at Milton High School?
2. Who decides whether the class is approved?
3. Who can aid me in providing advice on the implementation process?
4. Who has gone through the process before? Finding out who the key players are and listening to their advice will help speed the process and increase the success of implementing a new AP Environmental Science class.

Sub-problem- What curriculum is there that will help me teach this course and prepare students for the exam?

The answers to the following questions need to be compiled before the proposal of the class in October 2006.
1. Is there curriculum already available for an AP Environmental Science class?

2. What topics are covered in this class? Does the class have to be a full year or a semester?

3. How much of the AP Environmental Science curriculum is already covered in other Milton High School classes?

This information will be used to help explain what curriculum will be included in an AP Environmental Science Course.
Chapter IV:

Results

Sub-problem- What is the process of adding a new course at Milton High School?

Randy Refsland and Cindy Drury were the two people interviewed to answer this sub problem. They were interviewed because they are in charge of approving new classes school wide before they can be taken to the school board. Both were interviewed on August 30, 2006.

Randy Refsland is the principal at Milton High School. He has been the principal for three years. He has the last say on whether or not the class gets proposed to the school board. He also knows the process for getting a new course approved and the steps that need to be followed to have a new class approved. The questions posed to Mr. Refsland are listed below followed by his responses.

1. Where do you see the Milton agriculture department in the future?

   I see it to be a popular program with it meeting the needs of many of Milton’s students.

2. What do you think about the statewide push to have agriculture classes counted as science credit?

   I think that it is an important idea for many communities and programs for them to survive budget cuts. In Milton that is not a huge deal. We have almost 95% of our students that already take three years of science.
3. What do you think about an Advanced Placement class being taught in the agriculture department?

What class would be taught?

4. How do you feel about AP Environmental Science class being taught out in the agriculture department?

I think that an AP class being taught in the agriculture department would get rid of any stigmas people have about the validity of agriculture classes. I really feel that this is an idea that I would think about pursuing.

5. What is the process that has to be done to add a new class?

The first thing that has to be done is that you will have to fill out a new class proposal which includes your end of the proposal. That entails the purpose etc. of the class and why it is important for the students. After that you have to take it to the agriculture department and then to the science department. They are the ones who pretty much give it the approval. If the proposal makes it past them it pretty much will get approved.

6. How soon do you think that this idea could be approved?

If you worked on it I think that you could have it approved in three to five years.

7. What about for next year?

I think that you could propose it but I do not think that it has a great chance of getting approved. The reason is that you are only a third year teacher and the science department has not even heard of the idea yet and they need some time to soak it in before they would approve it.
Cindy Drury is a guidance counselor at Milton high school. She has had this job for over a decade. She is in charge of all of the scheduling and adding classes. The questions posed to Ms. Drury and her responses follow:

1. What is the process for adding a class on your end?

   The main thing for the guidance department is that you get the course description in on time so that we can get it put in the course selection book. The other thing is to make sure the prerequisites are clear so that teachers know how to sign students up for that class.

2. With the AP classes that are already offered how do you think an AP Environmental Science class would fit into the schedule?

   As you know the students who take AP classes are the ones that usually take more than one of them. This is the part of scheduling that makes it difficult because you have to make sure that none of them conflict because there is usually only one section of those AP classes. I think that it would fit and maybe one or two students might have to decide between two AP classes but that is how all of them work so I think that it would be fine.

Sub-problem- What does the AP Environmental Science exam offer students who pass the exam?

In 2006, AP courses were offered in more than 16,000 schools. That same year, 2,312,611 AP Exams were administered worldwide to 1,339,282 students. Most colleges
and universities in the United States and Canada, as well as colleges and universities in
40 other countries, have a policy granting incoming students credit, placement, or both,
for qualifying AP Exam grades (AP Program 2006). In Wisconsin in 2003-2004 17,043
juniors and seniors took one or more AP Exams while in 2004-2005 18,315 students took
one or more AP Exams. 75% of all high schools in Wisconsin offer at least one AP
Exam (Burnmaster 2006).

Jeff Hicken is the agriculture DPI contact. He is in charge of organizing all of the
agriculture teachers in the state. He understands where the agricultural industry and
where agriculture education programs are going. The questions posed to Mr. Hicken and
his responses follow:

1. How important is it that agriculture programs have at least a class that counts for
science credit?

With the push in the state for high schools to require three years of science for
graduation, agriculture programs have a huge opportunity to take advantage of.
Many programs teach so much science already that it is not that big of a step. The
classes that programs already teach like animal and plant science should just need
to be aligned to science standards to be counted. The other area is natural
resources. These are all areas agriculture teachers already teach and the classes
are heavily science orientated.

2. Are there any agriculture teachers in the state that are teaching AP Environmental
Science classes?

I do not think so. I still have to talk with a few. I know that this is a big topic and
I have been asking around. I have found out that you do not have to have an AP
Environmental Science class for a student to take the AP Environmental Science test. All they have to do is pay the fee. I am going to see this year if we have any agriculture teachers who would like to have their students take the AP Environmental Science test after taking the Natural Resources class in the agriculture department.

3. Are any teachers in the state pursuing this?

I have had a lot of interest when presenting this idea the past couple of weeks. I think that we are going to have a hand full of agriculture teachers with students taking the AP Environmental Science test.

Sub-problem- Who are the key players involved in the process of implementing more environmental science into the curriculum?

Bob Johnson is the head of the Agriculture department. He has been teaching for twenty-seven years and for the past two years he has been half time agriculture teacher and half time dean of students. He is a person that everyone goes to for questions on how to accomplish things at the high school. He was asked the following questions and gave the following responses. The interview took place on August 30, 2006.

1. When was the last time the agriculture department proposed a new class?
In 1999 Jonathon Ganske proposed a new class dealing with Veterinarian Science.

2. Why was the class approved or not?

The class was not approved. It was not the right time to propose a new class.

3. Did he try to propose the class again? Why or why not?

No he did not try again. In my opinion he never felt the right time for him came up.

4. With the push for science standards being taught in the agriculture curriculum do you think a new class proposal is an option?

It depends on the situation and the goal of the class. The science department is going to have a say if you offer a class that is going to count for science. I think that it would be a great thing for the agriculture department and give validity to the program if a new class was proposed.

5. What do you see as the major hurdles for a new class proposal?

The biggest hurdle is going to be the science department and the new class process. Proposing a class that potentially takes students away from other science classes may raise some issues. You need to have the science department on board to be able to accomplish it.
Sub-problem: What curriculum is there that will help teach this course and prepare students for the exam?

Many resources are available to teach all of the topics presented in an AP Environmental Science class. The College Board has compiled a list of topics that are covered by the class and are also covered by the test. (Appendix D)

An interview was also conducted with Milton High School Environmental science instructor Dave Bendlin on November 15, 2006.

Dave Bendlin is the head of the science department and also teaches a semester course in environmental science. He has been teaching for 25 years and just won the Kohl teacher award. The questions posed to Mr. Bendlin and his responses follow:

1. What topics do you cover in your semester class of environmental science?
   The main topics that I cover include some tree identification and some plant identification outside. I also like to cover many environmental issues that are happening in our world today. A lot of what I cover deals with how we use resources and the impact it has on especially water and air.

2. What kind of student is the class designed for?
   The class is designed for students who do not have the desire or the ability to take any of the AP science classes. I do not teach many advanced topics.

3. Have you ever thought or wanted to teach an AP Environmental Science class?
I had thought about it but I did not know if there was a need for it. Before the past five or six years we were a small school with a limited number of students and the science department had so many AP Science classes already that I did not think there was a need.

4. Have you thought about it now that the school has grown?

I have but it is not something that I am going to pursue. I am far enough along in my career that by the time I got the class running how I want it to run I would be retiring.

5. One of my goals is to teach an AP Environmental Science class. I am certified in Agriculture, Biology, and soon Environmental Science. Do you think it would be feasible for me to teach that class with it counting for science credit?

I think it is feasible. The major hurdles are going to be the teachers that already teach AP science classes. You are going to have to convince them that this class is not going to take students from them and kill their classes. It would have to be well presented to have the science department approval.
Chapter V

Conclusions:

Advanced Placement exams offers a student the ability to receive college credit while still attending high school. Any student may take an AP exam no matter what their high school classes consist of as long as they register and pay for the exam. All major colleges and universities in the United States and around the world will almost always accept credits from the AP exam.

After numerous interviews and figuring out who the key players are in deciding whether to add a new class at Milton High School I have determined that the head of the Agriculture department, the principal, the head of the science department, and the scheduling counselor all have a role in adding a new class. The process consists of a written proposal followed by a proposal to the agriculture department, science department, principal, and then to the school board. All of these people have to give their stamp of approval for the class to be approved.

There is much curriculum available to use in teaching AP Environmental Science. There is no set curriculum prescribed by the College Board for AP Environmental Science. There are topics that are to be meet if a student is to pass the AP Environmental Science test (Appendix D).
Recommendations:

After compiling all of my research I have decided that the best way to incorporate AP Environmental Science Curriculum and to prepare students for the AP Environmental Science exam would be to infuse the curriculum that I have acquired into my already existing Wildlife and Natural Resources class. I came to this conclusion after the tone of the interviews with the key players in Milton High school. I interpreted the tone as though this is not the right time to be proposing new classes in the department. I determined that I would infuse the areas of the exam that I feel are not covered by other classes. The following curriculum acquired and compiled is to fill the year long class Wildlife and Natural Resources. This class is a junior and senior level class that is already taught in the agriculture department. The class meets everyday and consists of a fifty-two minute class period. The goal of adding curriculum is so that at the end of the year the student is prepared to take the AP Environmental Science Exam. Appendix A shows the syllabus that has been put together with the addition of AP Environmental Science topics that were added but still fit into the curriculum of the class. Appendix B shows which AP Environmental Science topic is covered by each of the lessons. The topics are labeled in outline form and the appendix puts the numeral/letter of the topic next to the lesson in which it was covered.
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Developing a School District Curriculum Plan for Education About the
Environment: How to use this Guide
Appendix A

Wildlife and Natural Resources Syllabus

This syllabus is designed for a yearlong class with fifty-two minute class periods. It is broken up by quarter and each day of the quarter. The lesson names are then given.

<table>
<thead>
<tr>
<th>QUARTER</th>
<th>DAY</th>
<th>LESSON NAME</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Expectations/ Get to know you</td>
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<tr>
<td>1</td>
<td>2</td>
<td>Red Green Game</td>
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<td>1</td>
<td>3</td>
<td>FFA Introduction and Recruitment</td>
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<tr>
<td>1</td>
<td>4</td>
<td>Urban Bird Study Introduction and Life List</td>
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<tr>
<td>1</td>
<td>5</td>
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<td>6</td>
<td>Understanding Forest Ecology</td>
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<td>Recognizing the Importance of Forests</td>
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<td>8</td>
<td>Important Tree Species and Their Products</td>
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<td>9</td>
<td>Urban Bird Study</td>
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<td>Role of Government in Forest Management</td>
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<td>Growth and Decline of Forest Trees</td>
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<td>Identifying Diseases and Pests of Trees</td>
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<td>Protecting and Preserving Wood</td>
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2 30 Taxidermy Introduction and History
2 31 Movie
2 32 Taxidermy Video Demonstration
2 33 Taxidermy Video Demonstration
2 34 Taxidermy Video Demonstration
2 35 Taxidermy Skin and Flesh
2 36 Taxidermy Skin and Flesh Pickle
2 37 Taxidermy Tanning Solution
2 38 Taxidermy Oil and Stretch
2 39 Taxidermy Oil and Stretch
2 40 Taxidermy Oil and Stretch
2 41 Urban Bird Study
2 42 Cheat Sheet For Exam
2 43 Semester Exam
2 44 Semester Exam
2 45 Semester Exam

QUARTER
3 1 Understanding Hunting Safety
3 2 Hunting Ethics
3 3 Hunting Equipment
3 4 Boating and Fishing Safety
3 5 Trapping lesson 1
3 6 Trapping lesson 2
3 7 Trapping lesson 3
3 8 Trapping lesson 4
3 9 Fur bearer project
3 10 Fur bearer project
3 11 Fur bearer project
3 12 Identifying and Classifying Game Animals
3 13 Foods and Environmental Requirements
3 14 Fur-Bearing Animals
3 15 Planet Earth Series
3 16 Planet Earth Series
3 17 Planet Earth Series
3 18 Planet Earth Series
3 19 Urban Bird Study
3 20 Managing Wildlife Habitats
3 21 Managing Wildlife Populations
3 22 Harvesting and Preparing Game Animals
3 23 Big Game Trip Planning
3 24 Big Game Trip Planning
3 25 Study Guide
26 TEST- Safety/Trapping/Game Management
27 Identifying and Classifying Game Birds
28 Food and Environmental Requirements
29 Raising Game Birds
30 Evaluating Wildlife Habitats
31 Managing Wildlife Populations
32 Harvesting and Preparing Game Birds
33 Urban Bird Study
34 Game birds project
35 Game birds project
36 Turkey Call Activity
37 Defining Prairies
38 The Importance of Prairies
39 Exploring Prairie Ecology
40 Establishing Prairies
41 Maintaining Prairies
42 Exploring Wetlands
43 Urban Bird Study
44 Importance of Wetlands
45 Wetland Ecology

QUARTER
1 Establishing Wetlands
2 Maintaining Wetlands
3 TEST- Game Birds/Prairies/Wetlands
4 Eco-Footprint packet
5 Energy
6 Energy
7 Energy
8 Energy
9 Energy
10 Population
11 Population
12 Population
13 Urban Bird Study
14 The Water Cycle
15 Determining Uses of Water
16 Identifying Water Sources and Quality
17 Reducing Water Pollution
18 Maintaining Watersheds
19 Conducting Water Quality Tests
20 Tracking Groundwater Contamination
21 Planet Earth Series
Appendix B

Syllabus Aligned to AP Environmental Science Topics

The following topics are presented on the AP environmental science exam. Each of the lessons from the previous syllabus was put under which AP environmental science topic it covers.

I. Earth Systems and Resources

   a. Earth Science Concepts
      LESSONS-

   b. The Atmosphere
      LESSONS-

   c. Global Water Resources and Use
      LESSONS- The Water Cycle, Determining Uses of Water, Identifying Water Sources and Quality, Maintaining Watersheds, Conducting Water Quality Tests

   d. Soil and Soil Dynamics
      LESSONS- Sand County Almanac lesson

II. The Living World

   a. Ecosystem Structure
      LESSONS- Urban Bird Study, Important Tree Species and Their Products, Exploring Natural Resources, Understanding Ecology and Ecosystems, Venison Processing, History and Importance of Wildlife Conservation, Wildlife Habitat and its Importance, Identifying and Classifying Game Animals, Fur-Bearing Animals, Planet Earth Series, Harvesting and Preparing Game Animals, Big Game Trip Planning, Identifying and Classifying Game Birds, Game birds project

   b. Energy Flow
      LESSONS- The Food Chain and Natural Selection, Trapping lessons, Foods and Environmental Requirements

   c. Ecosystem Diversity
      LESSONS- Understanding Life Processes, Trapping lessons, Wetland Ecology
d. **Natural Ecosystem Change**  
LESSONS- Whitetails- Introduction, Whitetails- Regulations,

e. **Natural Biogeochemical Cycles**  
LESSONS-

### III. Population

a. **Population Biology Concepts**  
LESSONS- Whitetails- Quality Deer Management, Antler Scoring Practice

b. **Human Population**
   i. **Human Population dynamics**  
      LESSONS- Population lesson 1
   
   ii. **Population size**  
      LESSONS- Population lesson 2
   
   iii. **Impacts of population growth**  
      LESSONS- Human Demands on Natural Resources, Natural Resource Conservation, Understanding Recycling, Population lesson 3

### IV. Land and Water Use

a. **Agriculture**
   iv. **Feeding a growing population**  
      LESSONS-
   
   v. **Controlling pests**  
      LESSONS-

b. **Forestry**  

c. **Rangelands**  
LESSONS-
d. Other land use
   i. Urban land development
      LESSONS- Identifying Problems Caused By Wildlife,
   
   ii. Transportation infrastructure
      LESSONS-

   iii. Public and federal lands
      LESSONS- National and State Park Project,

   iv. Land conservation options
      LESSONS- Who's Who in Conservation, Exploring Wetlands, Establishing Wetlands, Maintaining Wetlands

   v. Sustainable land-use strategies
      LESSONS- Sand County Almanac, Whitetails- Quality Deer Management, Managing Wildlife Habitats, Fish Digestion and Feeding, Propagating and Selling Fish, Identifying Fish and Facilities, Diagnosing Fish Diseases, Harvesting, Holding, Transporting Fish, Wisconsin Fish Identification, Fishing lures

e. Mining
   LESSONS-

f. Fishing
   LESSONS- Exploring Aquaculture, Environmental Requirements for Fish, Nutritional Requirements for Fish

g. Global Economics
   LESSONS-

V. Energy Resources and Consumption
   a. Energy Concepts
      LESSONS-

   b. Energy consumption
      i. History
         LESSONS-

      ii. Present global energy use
         LESSONS-

      iii. Future energy needs
         LESSONS-
c. Fossil Fuel Resources and Use
   LESSONS-

d. Nuclear Energy
   LESSONS-

e. Hydroelectric Power
   LESSONS-

f. Energy Conservation
   LESSONS- Eco-Footprint lessons, Energy Lesson 1, Energy lesson 2

g. Renewable Energy
   LESSONS- Energy lesson 3, Energy lesson 4

VI. Pollution
   a. Pollution types
      i. Air pollution
         LESSONS- Recognizing the Importance of Forests

      ii. Noise pollution
         LESSONS- Selecting Trees for Urban Growing Conditions,

      iii. Water pollution
         LESSONS- Reducing Water Pollution, Tracking Groundwater Contamination

      iv. Solid waste
         LESSONS-

   b. Impacts on the Environment and Human Health
      i. Hazards to human health
         LESSONS-

      ii. Hazardous chemicals in the environment
         LESSONS-

c. Economic Impacts
   LESSONS-

VII. Global Change
   a. Stratospheric Ozone
      LESSONS-

   b. Global Warming
      LESSONS-
c. Loss of Biodiversity
   i. Habitat loss
      LESSONS- Sand County Almanac, Describing Species
               Endangerment, Conserving Wildlife and Habitat, Exploring
               Wetlands
   ii. Maintenance through conservation
       LESSONS- Sand County Almanac, Creating Wildlife Habitat,
                 Defining Prairies, Establishing Prairies, Maintaining Prairies,
   iii. Relevant laws and treaties
        LESSONS-
Appendix C

Lesson Plan Examples

Introduction- The following lessons were made and compiled to add into the Wildlife and Natural Resources class.

School Site Overview- The Milton High School is located on the south side of Milton. The school has only a park on the south side before it is agricultural fields. On the site there are all of the athletic facilities including 4 practice football fields, a game field for football and soccer, 2 practice soccer fields, 6 tennis courts and 6 baseball/softball fields. There is also the track and another paved walking/running area. On top of the athletic fields there is an overgrown field, which is the future building site and an outdoor laboratory. This laboratory consists of an overgrown area consisting of mostly box elder and honeysuckle plants and also another area with a small prairie, pine trees and walnut trees. There are various flower gardens on the grounds and trees planted for aesthetic value.

Activities/Lessons Infusing the Outdoor laboratory- In the past I have only went outdoors for two units. The first unit was the forestry unit. I used the outdoor laboratory to do tree identification, tree measurement, and different activities dealing with habitats. The second unit that I use the outdoor laboratory for is the soils unit. We discuss erosion and slope of the land comparing it with its use. This year I would like to infuse a birding unit into the curriculum and incorporate the outdoor laboratory again. In this unit I plan
to be using the outdoor lab at least once a month where students will be observing which birds are present. Various activities will be done in this year long unit.

**Birding Lessons and Activities**- High school lesson plans have been hard to find dealing with birding. I budgeted last year for 30 copies of Petersons Field Guide and 30 pair of binoculars. I have take some ideas from many areas but I have created my own lesson plans to fit my time allotment and what I feel are the needs of the students that I have in class. I have planed one day of introduction and 12-14 other days of observation outside dealing with birding.

**Lessons, Activities, Worksheets**- The following lessons is what I plan to give my students for lessons and activities throughout the year.
Urban Bird Study Lesson

Objectives: 1. Students will be able to safely use and handle binoculars.
2. Students will be able to identify birds using the field guide.
3. Students will be able to start their life birding list.
4. Students will be able to make the most use of their time outdoors.

Materials Needed: notebooks, writing utensil, checklist of Wisconsin birds, bird field guide, and binoculars

Procedure: I. Hand out checklist, field guide, binoculars
II. Go over how to use binoculars, names of pieces, how to use it
III. Go over checklist, all of the abbreviations, how to use it, what to check off, how it is arranged.
IV. Explain all of the pieces of the field guide. Explain how to use it and where to look for different things that will help you to determine what kind of specie it is. Practice with some examples.
V. Explain the rules when we are doing the urban bird study.
   a. An alone activity. You are not to be around others or talking to others. If you have a question you need to ask the instructor.
   b. Pick a spot and stay there. Do not get up and move around.
   c. You can bring your own seat if you do not wish to sit on the ground.
   d. 10pt activity for participation
   e. Failure to obey means a 0 and next time you will be inside doing current events.

Reflection:

 Checklist of Wisconsin Birds, Great Wisconsin Birding and Nature Trail, WIDNR

Standards:
Birding and Binocular Notes

**Prism**- makes the object appear right side up and the correct way left to right

**Roof prism**- one of the main styles of binoculars; if eyepieces are in line with each other it is a roof prism

**Porro prism**- one of the main styles of binoculars; if eyepieces are not in line with each other it is a porro prism

**7X42**- pronounced seven by forty-two; fist number is the power of the binoculars and tells you how many times as big the image will appear; second number is the diameter of the objective lenses in millimeters. It tells you the light gathering ability

**Exit pupil**- how well a binocular performs in dim light; higher the better

**Eye relief**- how far back the eye can be and still see the whole picture; important if you have glasses

**Coated and multi-coated glass**- reduces reflection

**Field of View**- horizontal width of the image; width of feet you can see at 1000 yards

**Life List**- a compile of birds see by a birder throughout their entire lifetime

**Determine what makes a bird go into each of the categories using your field guide.**

Duck and ducklike birds-

Gulls and terns-

Long-legged waders such as herons-

Shorebirds and smaller waders-

Fowl-like birds such as grouse-
Describe each of the following bird characteristics that will help you to identify a bird outside. Use pages 8-13 of the field guide

Shape of body-

Shape of wings-

Shape of bill-

Shape of tail-

Behavior-

Tree climbing-

Flying-

Swimming-

Wading-
Field marks-

Tail patterns-

Rump patches-

Eye stripes and eye rings-

Wing bars-

Wing patterns-

Gender Symbols-

Rare-

Casual-

Accidental-

Vagrant-

Local-

Introduced-

Exotic-

In part-

Why are range maps important?
Objectives: 1. Students will be able to safely use and handle binoculars.  
5. Students will be able to identify birds using the field guide. 
6. Students will be able to start their life birding list. 
7. Students will be able to make the most use of their time outdoors. 

Materials Needed: notebooks, writing utensil, checklist of Wisconsin birds, bird field guide, and binoculars

Procedure: I. Hand out checklist, field guide, binoculars 
II. Go over how to use binoculars, names of pieces, how to use it 
III. Go over checklist, all of the abbreviations, how to use it, what to check off, how it is arranged. 
IV. Explain all of the pieces of the field guide. Explain how to use it and where to look for different things that will help you to determine what kind of specie it is. Practice with some examples. 
V. Explain the rules when we are doing the urban bird study. 
   a. An alone activity. You are not to be around others or talking to others. If you have a question you need to ask the instructor. 
   b. Pick a spot and stay there. Do not get up and move around. 
   c. You can bring your own seat if you do not wish to sit on the ground. 
   d. 10pt activity for participation 
   e. Failure to obey means a 0 and next time you will be inside doing current events. 
VI. Return inside and discuss the conditions of the day and what birds were observed. 
VII. Option for each of the days include putting them in different areas of the school site including the pine/walnut area, boxelder/honeysuckle area, overgrown area, athletic fields, near the cornfield, or a walking observation. 

Reflection:


Checklist of Wisconsin Birds, Great Wisconsin Birding and Nature Trail, WIDNR

Standards:
### Urban Bird Survey
Wildlife and Natural Resources 2006-2007

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**Standards Addressed by Unit:**


**References:**
Peterson, Roger and Virginia; Petersons Field Guide to Birds of Easter and Central North America; 5th edition; 2002
WI DNR; Checklist of Wisconsin Birds Great Wisconsin Birding and Nature Trail; Bureau of Endangered Resources

http://www.birdwatching.com/optics/binocglossary.html
http://www.birds.cornell.edu/
Lab Sheet

PLANTING A TREE

Objective:

Students will follow approved practices in planting a tree.

Materials:

Balled and burlapped, bare-root, or containerized tree(s)
Round point shovels
Mulch
Water
Knife

Procedure:

1. With approval of the school administration identify locations for planting trees.
2. Dig the planting hole at least 12" wider than the soil ball. The larger the hole, the better. The hole should be deep enough so the top of the soil ball is level with the surface of the surrounding soil. A plant should never be planted deeper than it was originally. On occasion when the soil is poorly drained or wet, the soil ball can be planted a little higher than the surrounding soil.
3. Once the hole has been checked against the size of the ball for depth, carefully place the plant in the hole with the burlap and twine intact. Handle the plant by the root ball.
4. Once located, remove all twine, particularly if it is nylon twine. Remove burlap as well. At minimum fold brown burlap down into the hole. Green burlap is treated with preservative and must be removed. Plastic wrap must also be completely removed. Metal cages can remain.
5. Position the plant with the best side facing toward the main viewing point. Position the tree so that it is perpendicular to the ground. Stand back and eye the tree. Holding a spade handle between the thumb and forefinger, letting it hang like a plumb, and lining one eye up with the trunk and the handle is one way to check the straightness of the trunk.
6. Once in position, fill the planting hole half way with the same soil that came from the hole. Carefully tamp the soil down by stepping on it.
7. Fill the hole with water and let it soak into the soil and soil ball.
8. Complete the backfill process. Do not pack the soil by stepping on it.
Lesson B5–4

Pruning Trees in Urban Settings

Unit B. Plant Wildlife Management

Problem Area 5. Urban Forestry

Lesson 4. Pruning Trees in Urban Settings

Learning Goal: Understand the fundamental concepts, principles and interconnections of the life, physical and earth/space sciences.

Learning Standard: Know and apply concepts that describe how living things interact with each other and with their environment.

Learning Benchmark: Compare and predict how life forms can adapt to changes in the environment by applying concepts of change and constancy (e.g., variations within a population increase the likelihood of survival under new conditions).

Career Development Competencies: Identify solutions to a problem and their impact.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Identify reasons for pruning urban trees.
2. Describe how to prune trees safely.
3. Explain how trees close their wounds.
4. Identify tools used in pruning trees.
List of Resources. The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:


Other Resources. The following resources will be useful to students and teachers:


List of Equipment, Tools, Supplies, and Facilities

- Writing surface
- Overhead projector
- Transparencies from attached masters
- Copies of student lab sheets
- Pruning tools

Terms. The following terms are presented in this lesson (shown in bold italics):

- Branch ridge bark
- Callus
- Chain saw
- Collar
- Compartmentalization
- Crossing branches
- Drop crotch cuts
- Hand pruner
- Heading cuts
- Leader
- Loppers
- Pole saw/pruner
- Pruning
- Pruning saw
- Rootstock
Scaffold branch
Scion
Subordination
Sucker
Thinning cut
U-shape crotch
V-shape crotch
Watersprout

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Ask the students if they have ever seen a large limb that has split off from a tree or if they have seen damage to trees caused by an ice storm. Permit time for students to share their experiences with one another. Share photos of damage caused by weak branching structures due to lack of proper pruning. Ask them to identify any other reasons to prune trees. Introduce the lesson by stating the objectives to be covered.

Summary of Content and Teaching Strategies

Objective 1: Identify reasons for pruning urban trees.

Anticipated Problem: What are the reasons for pruning urban trees?

I. Pruning is the term used for the selective removal or reduction of certain plant parts. Trees are pruned for a variety of reasons. Proper pruning leads to attractive, healthy trees. Some of the reasons for pruning trees include the following:

A. Promote the development of a strong framework of branches.
B. Restrict the size of the plant.
C. Repair damaged limbs.
D. Improve flowering displays.
E. Reduce the spread of pests by removing diseased limbs.
F. Direct the plant’s growth in a particular direction.
G. Maintain desired cultivars.
H. Open the crown to allow for light and wind to pass.
I. Maintain safe conditions for humans.
J. Improve fruit quality.

Use an interest approach to capture the attention of the students. Following the interest approach prepare the students by clearly stating the objectives of this lesson and terms to be defined. Assign appropriate selections from the recommended text materials for the students to read. They should note key points pre-
Objective 2: Describe how to prune trees safely.

Anticipated Problem: What techniques are used to prune trees safely?

II. Approved techniques have been established for pruning trees safely. Make good decisions as to why and how a tree is be pruned before any cut is made. All cuts should contribute to the pruning goals that have been established. It is important to understand the parts of trees, the best times to prune, how trees heal, and how to remove large limbs.

A. Some general rules of pruning should be kept in mind.
   1. Make cuts that will cause the least amount of damage to the tree.
   2. Begin pruning the tree while it is young.
   3. Choose the tools most suitable for the job, keep them sharp, and use them safely.

B. Knowledge of major tree structures and their functions is important.
   1. A leader is a central branch that is dominant over other branches on the tree. It leads the growth of the tree. Co-leaders are not desirable. They are unattractive and lead to the development of weak V-shaped crotches. When co-leaders exist, the less desirable one of the two should be removed.
   2. Scaffold branches grow laterally from the trunk. The trees' weakest point is where scaffold branches attach to the trunk. The angle of attachment to the trunk influences the structural soundness scaffold branches.
      a. U-shaped crotches are created by branches that attach to the trunk at angles of 45° to 90°. These branches are structurally sound due to the wide angle.
      b. V-shaped crotches are created by branches that attach at sharp angles. The joint is weak because the bark is crushed between the branches as the tree grows and expands. Trees with V-shaped crotches are prone to splitting.
   3. Watersprouts are soft, green shoots that usually grow vertically from existing branches. If allowed to grow, they may cross and rub against other branches. They should be removed from the tree.
   4. Crossing branches are those branches that grow in different directions and make contact with one another. The friction created by the rubbing together of these branches may open wounds. The wounds allow disease and insects to enter. In addition, they are unattractive. Regular removal of branches that are growing towards the tree's center will eliminate most crossing branches.
   5. Suckers are soft, green shoots that develop at the base of the tree. Like watersprouts, suckers are of no ornamental value to the tree. It is particularly important to remove suckers from grafted plants. In grafting, the rootstock (root system) has different
qualities than the scion (top growth). If suckers from the rootstock are allowed to grow, they will interfere with the desired ornamental effect of the scion.

6. Dead, diseased, and broken wood should be removed from the tree. Removal of dead and diseased wood reduces the spread of disease. Pruning dead wood also eliminates safety hazards.

C. When to prune relates to the season of the year in which trees are cut and the tree’s stage of maturity at which the pruning is carried out.

1. Late winter and early spring are the best times to prune most deciduous trees. Pruning at that time of year, when trees are dormant, has advantages:
   a. Branching structure is more visible without the presence of leaves.
   b. The limbs are much lighter without leaves.
   c. Tree cuts made at these times of the year give the tree an entire growing season in which to heal.

2. Some trees such as maples, birches, and elms will ooze sap if pruned in the late winter or early spring. Although the sap causes no damage, it is best to prune these types of trees in midsummer when the sap is not flowing.

3. Pruning newly transplanted trees requires special considerations and should be done with restraint. The key to a tree’s survival is its ability to develop a new root system. Removing limbs means the loss of energy from producing leaves and storing starches that contribute to root growth and development. Removal of over 15 percent of the crown at the time of transplanting slows tree growth for several years. Pruning of newly transplanted trees should be restricted to the removal of co-dominant leaders, dead and diseased wood, and V-shaped crotches.

4. A tree’s second pruning should occur two to four years after planting. During the second pruning, crossed branches, limbs that have died back, and some lower branches are removed. To contribute to a strong trunk, it is best to not remove all of the lower branches at once.

5. The tree should be pruned again five to seven years after planting. The amount to be removed should be minimal.

D. Subordination is an important concept in pruning. Subordination involves cuts made that slow the growth of a branch, and is accomplished by removing lateral branches and/or reducing the length of the parent branch cause the branch to become subordinate or less dominant.

Subordination is used with all tree sizes, and is often most appropriate when multiple leaders on a small tree are involved. Identify the best of the leaders, and prune the others. The pruned branches will grow more slowly than the un-cut branch selected to be the leader. The un-cut branch will emerge as the dominant leader, while the others will become major limbs of the tree.

E. Three basic techniques are used to prune trees. They include drop-crotch cuts, thinning cuts, and heading cuts.
1. **Drop-crotch cuts** are effectively used to shorten tree limbs and reduce the size of a tree. It involves cutting the leader limb back to a lateral branch. The lateral branch remaining should be at least one-third the diameter of the leader removed.

2. **Thinning cuts** are those cuts made to remove a branch from the parent stem or trunk. They open up the tree rather than reduce its size. This is the most common pruning method for large, established trees.

3. **Heading cuts** are made between the nodes on a stem with a hand pruner or lopper. Heading cuts are commonly used with nursery stock.

4. Procedures for removing large limbs should be followed to ensure safety. Large limbs can be very heavy. Such weight will not only injure people, but it can also damage the tree if the limb is not removed properly. Improper removal often strips bark from the tree. Removal of large limbs involves a series of cuts.
   a. Make an undercut about 1/3 of the way through the limb about a foot from the trunk.
   b. Make the second cut the upper side of the limb about 1 inch from the under cut. This cut should be made closer to the trunk than the first cut to swing the branch toward the tree before it drops or further from the trunk for the limb to drop without swinging.
   c. Make the final cut closer to the trunk than the previous two. The proper cut is one that is made as close to the branch collar and branch bark ridge as possible without causing damage to those tissues. After the final cut is made, the wound should be left exposed. Sealers are never needed. They promote decay by keeping conditions moist for fungal and bacterial growth.

Have the students read related sections of text materials identified in the resources list. Students on the Internet can find additional information. One good site is the International Society of Arboriculture, www.isa-arbor.com. Require students to take notes on the major points presented in the TM: B5-4B—Tree Structure, TM: B5-4C—Pruning Obvious Faults, TM: B5-4D—Removing A Large Limb, TM: B5-4E—Final Cuts Of A Large Limb to illustrate concepts. Have the students expand their notes based on the discussion. Have the students follow the procedure in LS: B5-4A—Pruning A Tree to get hands-on experience in pruning trees. The discussion can also serve as a way to monitor students’ mastery of the material.

**Objective 3:** Explain how trees close their wounds.

**Anticipated Problem:** How do trees close their wounds?

III. Trees have the ability to close or seal wounds with chemicals that inhibit decay caused by fungi and bacteria. This form of defense is called compartmentalization.

A. At the base of every branch there is a branch bark ridge and a collar. The *branch bark ridge* is a raised line of bark that forms on the upper side of where the branch joins the bark. The *collar* is the swollen tissue surrounding the base of the branch. These structures contain chemicals that inhibit the spread of disease. It is important that during the
pruning process that the branch bark ridge and collar tissues that defend the tree from infection and decay are not damaged.

B. When a tree is wounded, it begins to form a callus, or protective growth of tissue over the wound. Eventually, the callus growth covers the wound.

Have the students read related sections of text materials identified in the resources list ideas sections that pertain to tree biology. Require students to take notes on the major points presented in the chapter. Follow the reading session with a discussion on compartmentalization. Have the students expand their notes based on the discussion.

**Objective 4:** Identify tools used in pruning trees.

**Anticipated Problem:** What tools are used in pruning trees?

IV. There are a number of tools used for pruning purposes. Proper tool selection for the job and safety are primary concerns.

A. **Hand pruners** are best used on small branches. **Loppers** are used for somewhat larger branches. The two major styles for both of these tools are scissors and anvil. Scissor style pruners are preferred as the blade slices the plant stem. Anvil style pruners are less desirable as plant stems are crushed when cut.

B. **Pruning saws** have larger teeth with wider spacing than carpenter’s saws. The large teeth and spacing ease the cutting of larger limbs.

C. **Pole saws/pruners** are specialty tools that allow a person to reach high limbs from the ground.

D. **Chain saws** are gas powered or electric and have a chain that cuts continuously. They are best used on large limbs. Chain saws are extremely dangerous if used improperly. To avoid hazards, obtain training on their safe operation. Some safety tips follow:
   1. Study branches before making any cuts.
   2. Accelerate the saw before beginning a cut.
   3. Keep feet completely still while the chain is turning.
   4. Do not use the guide bar’s upper tip for cutting.
   5. If pinching occurs, shut the saw off before extracting the saw blade.
   6. Wear proper safety gear.

Bring pruning tools to class. Discuss their features, maintenance, and safe use. Use TM: B5-4F—Pruning Tools to show the types of tools used. Set up a field trip to witness arborists at work. Ask an arborist to explain pruning techniques and practices used in the field. Get the students ready for the visit by having them prepare questions in advance. Review the material presented. Evaluate student mastery of the material by administering a written exam and through laboratory work.

**Review/Summary.** Restate the student learning objectives at the conclusion of the lesson. Review the material that has been covered in class discussions, laboratory activities, and
other learning experiences. Call on students to explain the content associated with each objective. Use their responses as the basis for determining any areas that need re-teaching. Questions at the end of the chapters in the textbook may also be used in the review/summary. Reinforce student learning by having students work with trees on the school grounds or off campus.

**Application.**

**LS: B5-4A—PRUNING A TREE**

**Evaluation.** Focus on student achievement of the objectives for the lesson when evaluating student performance. Use various evaluation techniques, such as student performance during oral review of the material, application of skills in the land lab setting, completion of the laboratory sheet, and a written exam. A sample written test is included with this lesson and can be adapted to local needs.

**Answers to Sample Test:**

**Part One: Matching**

1 = e, 2 = a, 3 = h, 4 = b, 5 = g, 6 = i, 7 = f, 8 = c, 9 = d, 10 = j

**Part Two: Completion**

1. Subordination, lateral branches, parent branch
2. compartmentalization
3. removed
4. V-shaped crotches
5. Watersprouts
6. Late winter, early spring
7. Drop-crotch cuts, leader limb, 1/3
8. strips bark from the tree
9. left exposed
10. branch bark ridge, a collar

**Part Three: Short Answer**

1. Promote the development of a strong framework of branches.
2. Restrict the size of the plant.
3. Repair damaged limbs.
4. Improve flowering displays.
5. Reduce the spread of pests by removing diseased limbs.
6. Direct the plant's growth in a particular direction.
7. Maintain desired cultivars.
8. Open the crown to allow for light and wind to pass.
9. Maintain safe conditions for humans.
10. Improve fruit quality.

2. 1. Make cuts that will cause the least amount of damage to the tree.
   2. Begin pruning the tree while it is young.
   3. Choose the tools most suitable for the job, keep them sharp, and use them safely.

3. The key to a tree's survival is its ability to develop a new root system. Removing limbs means the loss of energy producing leaves and stored starches that contribute to root growth and development. Removal of over 15 percent of the crown at the time of transplanting slows tree growth for several years. Pruning of newly transplanted trees should be restricted to the removal of co-dominant leaders, dead and diseased wood, and V-shaped crotches.

4. 1. Make an undercut about 1/3 of the way through the limb about a foot from the trunk.
   2. Make the second cut the upper side of the limb about 1 inch from the under cut. This cut should be made closer to the trunk than the first cut to swing the branch toward the tree before it drops or further from the trunk for the limb to drop without swinging.
   3. Make the final cut closer to the trunk than the previous two. The proper cut is one that is made as close to the branch collar and branch bark ridge as possible without causing damage to those tissues.

5. 1. Study branches before making any cuts.
   2. Accelerate the saw before beginning a cut.
   3. Keep feet completely still while the chain is turning.
   4. Do not use the guide bar's upper tip for cutting.
   5. If pinching occurs, shut the saw off before extracting the saw blade.
Lesson B5–4: Pruning Trees in Urban Settings

**Part One: Matching**

*Instructions.* Match the term with the correct response. Write the letter of the term by the definition.

- a. Branch ridge bark
- b. Callus
- c. Collar
- d. Crossing branches
- e. Leader
- f. Pruning
- g. Pruning saw
- h. Scaffold branch
- i. Sucker
- j. U-shape crotch

1. ___________ a central branch that is dominant over other branches on the tree.
2. ___________ a raised line of bark that forms on the upper side of where the branch joins the bark.
3. ___________ branches that grow laterally from the trunk.
4. ___________ protective growth of tissue that grows over a wound.
5. ___________ saws that have larger teeth with wider spacing than carpenter's saws.
6. ___________ soft, green shoots that develop at the base of the tree.
7. ___________ term used for the selective removal or reduction of certain plant parts.
8. ___________ the swollen tissue surrounding the base of the branch.
9. ___________ those branches that grow in different directions and make contact with one another.
10. ___________ created by branches that attach to the trunk at angles of 45° to 90° resulting in structurally sound branches.

**Part Two: Completion**

*Instructions.* Provide the word or words to complete the following statements.

1. ________________ involves cuts made that slow the growth of a branch, and is accomplished by removing ________________ and/or reducing the length of the ________________ cause the branch to become subordinate or less dominant.
2. Trees have the ability to close or seal wounds with chemicals that inhibit decay caused by fungi and bacteria. This form of defense is called ________________.
3. When co-leaders exist, the less desirable one of the two should be ________________.
4. _________________ are created by branches that attach at sharp angles.

5. _________________ are soft, green shoots that usually grow vertically from existing branches.

6. _________________ and _________________ are the best times to prune most deciduous trees.

7. _________________ are effectively used to shorten tree limbs and reduce the size of a tree. It involves cutting the _________________ back to a lateral branch. The lateral branch remaining should be at least _________________ the diameter of the leader removed.

8. Improper removal of large limbs often _________________.

9. After the final cut is made in removing a limb, the wound should be _________________.

10. At the base of every branch there is a _________________ and _________________. These structures contain chemicals that inhibit the spread of disease.

**Part Three: Short Answer**

**Instructions.** Provide information to answer the following questions.

1. Give ten reasons for pruning trees.

2. What are three general rules in pruning trees?

3. What special considerations are involved when pruning newly transplanted trees?

4. What are the recommended steps in removing a large limb?

5. What are six safety tips for using chainsaws?
REASONS FOR PRUNING

1. Promote the development of a strong framework of branches.

2. Restrict the size of the plant.

3. Repair damaged limbs.

4. Improve flowering displays.

5. Reduce the spread of pests by removing diseased limbs.

6. Direct the plant's growth in a particular direction.

7. Maintain desired cultivars.

8. Open the crown to allow for light and wind to pass.

9. Maintain safe conditions for humans.

10. Improve fruit quality.
TREE STRUCTURE

U-shaped Crotch
Structurally Sound

V-shaped Crotch
Prone to Splitting

(Courtesy, Interstate Publishers, Inc.)
PRUNING OBVIOUS FAULTS

V-shape crotch

Diseased, broken, or dead limb

Watersprouts

Crossing branch growing towards center of tree

Suckers

(Courtesy, Interstate Publishers, Inc.)
REMOVING A LARGE LIMB

(Courtesy, Interstate Publishers, Inc.)
FINAL CUTS OF A LARGE LIMB

Proper Cut  Flush Cut  Stub Cut

Branch bark ridge
Branch bark ridge injured
Branch collar injured

Stub is vulnerable to insects and diseases

(Courtesy, Interstate Publishers, Inc.)
PRUNING TOOLS

Lopping Shears
Hedge Shears
Pole Saw with Pruner
By-pass Pruner
Anvil-and-Blade Pruner
Bow Saw
Curved-blade Hand Saw
Chain Saw

(Courtesy, Interstate Publishers, Inc.)
Lab Sheet

PRUNING A TREE

Objective:
Students will follow approved practices in pruning a tree.

Materials:
- Hand pruners
- Loppers
- Pruning saw
- Pole saw/pruners
- Safety goggles

Procedure:
1. Identify trees on the school campus in need of pruning.
2. Gain approval from the school administration to prune the trees.
3. As a class or in groups identify those limbs that should be removed.
4. With safety in mind prune the trees.
Urban Forestry Notes

Objective 1: Define urban forestry.

Anticipated Problem: What is urban forestry?

I. Urban forestry is a specialized segment of forestry.
   A. Urban forestry takes place in the populated areas of cities, towns, and suburban areas. Populated areas offer unique challenges in managing the trees not often found in traditional forests. Air pollution, confined growing space, and compacted soils are some factors that can make the management of trees difficult.
   B. Urban forestry requires a great deal of management by people. The culture or care of trees is arboriculture. Professionals that see to the culture of trees are known as arborists.
   C. Certification enhances an arborist’s credentials. State and national organizations provide certification training and testing. Certified arborists have proven through studies and exams that they are qualified for tree care work. They are typically regarded as being “professionals” in the areas of tree nutrition/fertilization, tree identification/selection, tree installation/establishment, safety/climbing, tree risk assessment, tree biology, pruning, diseases diagnosis/treatment, soil/water relationships, forest ecology, tree preservation/construction, and cabling/bracing.

Objective 2: Explain the benefits of an urban forest and urban trees.

Anticipated Problem: What are the benefits of urban forest and urban trees?

II. Benefits from urban forests may be related to the quality of life, the environment, and economics.
   A. Healthy urban forests improve the quality of life. Trees clean the air. They remove smog, dust, and pollutants from the air we breathe. That is important since we take 23,000 breaths in a day!
   B. Trees produce oxygen. An acre of trees produces enough oxygen everyday for 18 people.
   C. An acre of trees absorbs carbon dioxide. An acre of trees absorb enough carbon dioxide in one year’s time to offset the amount produced in driving a car 26,000 miles.
   D. Trees serve as barriers. Trees can lower sound pollution. Reduced noise levels near places of work and residence improve quality of life. Trees can block unsightly views such as industrial areas or highways. Trees also serve as windbreaks, which is particularly useful in the winter months.
E. Trees have a cooling effect on hot summer days. Air temperature under a large shade tree can be 15 degrees cooler than the temperature in the sun. As a result, cooling costs can be 10-50 percent lower.

F. A single large deciduous tree in leaf provides protection from ultraviolet radiation. The Sun Protection Factor (SPF) has been estimated at 10-20.

G. Trees are beautiful. Many trees have showy flowers, attractive foliage, interesting bark, and stunning fall colors. Well-landscaped houses with mature trees can be valued at 10-15% more than houses lacking trees.

H. Although difficult to measure, trees have a positive psychological affect on humans. Research has shown urban forests to be good for mental health.

I. Urban forests contribute to a healthy environment. They can reduce storm water runoff and reduce soil erosion. Trees produce oxygen needed by animals. Urban forests provide food and shelter for wildlife.

**Objective 3:** Describe various aspects of urban forest management.

**Anticipated Problem:** What are various aspects of urban forest management?

III. There are multiple aspects to managing an urban forest.

A. Urban forests are managed with different uses in mind. In urban settings trees impact watersheds, wildlife, fish habitats, recreational activities, aesthetics, general tree care, and wood production.

B. Urban forestry management programs have a variety of objectives. One objective includes inventorying trees as to species, size, age, and value. Care and maintenance of existing trees is important. Care includes the monitoring and managing of insect pests and diseases. An urban forest is constantly changing. Therefore, removal of trees due to death, decline, or safety considerations is necessary. By the same token, installation of trees is required to maintain the urban forest. Urban forestry management programs also address the need of educating the public on the role of trees in the environment. The general goals for most community forest programs tend to be similar.

1. Establish and maintain maximum tree cover.
2. Maintain trees in a healthy condition through good cultural practices
3. Establish and maintain an optimal level of age and species diversity.
4. Promote conservation of tree resources.
5. Select, situate, and maintain street trees appropriately to maximize benefits and minimize hazard, nuisance, hardscape damage, and maintenance costs.
6. Centralize tree management under a person with the necessary expertise.
7. Promote efficient and cost-effective management of the urban forest.
8. Foster community support for the local urban forestry program and encourage good tree management on privately owned properties.
9. Facilitate the resolution of tree-related conflicts between citizens.

C. Municipalities often adopt tree ordinances to meet goals of attaining a healthy, vigorous, and well-managed community forest. Tree ordinances provide the
authorization and standards for management activities. Tree ordinances can be grouped into three basic categories:

1. Street tree ordinances primarily cover the planting and removal of trees within public rights-of-way. They often contain rules regarding private trees, which pose a hazard to the traveling public. Tree planting requirements, such as those requiring tree planting in parking lots are generally outlined.

2. Tree protection ordinances involve protection for native trees or trees with historical significance. These ordinances usually require that a permit be obtained before protected trees can be removed and in some cases, pruned.

3. View ordinances outline rules pertaining to trees that block views or sunlight.

Objective 1: Understand the types of trees.

Anticipated Problem: What are the types of trees available?

I. It is important to define a tree and understand how trees are categorized.
   A. A broad definition of a tree is a single-stem, woody, perennial plant reaching the height of 12’ or more. There are exceptions in that some trees, such as birch and alders, are grown with more than one trunk and are called multi-stem trees. Other trees may not reach 12’ in height, but are still considered trees. Some trees have limbs to the ground, such as beech, fir, and pine.
   B. Plant nomenclature is used to help categorize trees.
      1. All cultivated trees have common and Latinized or botanical names. A tree may carry more than one common name. Confusion can take place when discussing a tree with multiple common names. However, a tree has only one botanical name. The botanical name is based on a binomial system, that is, the plant has two Latin names. The first of the two is genus, and second is species. A genus is a closely related group of plants comprised of one or more species. A species is composed of plants that show characteristics that distinguish them from other groups in the genus.
      2. Some trees have been selected for outstanding characteristics. In these cases the trees may be given a variety or cultivar name. A variety is a group of plants within a species that has a significant difference from other plants in the species. The trait passes on to the next generation through sexual reproduction. A cultivar is a tree with a distinguishing characteristic that does not transfer to the offspring through sexual reproduction.
      3. The botanic name must be written properly. The genus is always capitalized. The species is lower case. A variety name is written in lower case and in italics or underlined. A cultivar name is capitalized and placed in single quotations. For example, the variety of common honeylocust that is thornless is written as Gleditsia triacanthos inermis or Gleditsia triacanthos var. inermis. The cultivar, October Glory Red Maple, would be written as Acer rubrum ‘October Glory’
   C. Function is often an important consideration in tree selection. Some trees are deciduous, meaning they drop their leaves in the fall. Some trees are referred to as evergreen. They maintain green leaves throughout the year. The situation may call for deciduous of ever-green species. Shade trees are large trees with spreading...
canopies. Ornamental trees have aesthetic value in terms of flowers, fruit, fall color, growth habit, bark, etc. Ornamental trees are smaller in size.

Objective 2: Explain how climate influences tree selection.
Anticipated Problem: How does climate influence tree selection?
II. Extremes in regional temperatures can limit the species of trees that can be grown. Knowing the limits in advance can help in the selection process.
   A. Hardiness is a term that refers to the ability of a plant to withstand cold temperatures. The USDA Plant Hardiness Zone Map is useful in deciding what trees survive in a particular region in the United States. A zone 5 tree species is known to withstand temperatures as cold as -20 to -10 °F. The same tree species would either suffer or die in the next coldest zone.

   B. Heat Tolerance has received increased attention in recent years. The American Horticultural Society has developed a Plant Heat-Zone Map showing 12 zones in the United States. The number of days in which the temperature exceeds 86 °F is given for each zone. Some trees are more sensitive to heat than others, so the map aids in proper tree selection. The health of a tree species would suffer if in a zone warmer than the recommended zone.

Objective 3: Identify factors in selecting trees for the urban environment.
Anticipated Problem: What are some factors to consider in selecting trees for the urban environment?
III. A number of factors should be considered in selecting trees for urban situations.
   A. Tree species have characteristics that should be considered in the selection process.

   1. Urban areas have particular problems not often found in rural areas. One problem caused by manufacturing and automobile use is air pollution. Some trees, such as Ginkgo, red oak, and lindens are very tolerant to air pollution.

   2. The soils in urban areas are usually altered. Subsoil is brought to the surface, drainage patterns changed, and soil compacted. Tree species tolerant of these conditions are good selections.

   3. Salt is used on the highways and roads in northern regions to melt ice and snow. High salt concentrations are damaging to trees. In locations of heavy salt use, select trees that are tolerant to salt. Examples include honeylocust, goldenraintree, and green ash.

   4. Some tree species are messy in terms of fruit, twig, or exfoliating bark that drop to the ground. The mess on the ground can be unsightly and labor may be required for clean up.

   5. Life expectancy might be important. Some trees live for hundreds of years, while others are much shorter lived. Generally speaking short-lived trees are faster growing and have weaker wood than the older lived species.

   6. Resistance to problems associated with pests and disease organisms is considered an attribute. Selection of trees resistant to such problems translates into healthy trees that require less care.
7. Trees may suffer from physiological disorders. Often these problems are soil related. Drainage factors of the soil or pH of the soil can cause physiological disease. For example, pin oaks develop iron chlorosis or a yellowing of leaves when grown in alkaline soils. The pH of the soil restricts the absorption of iron.

8. Safety is a consideration in urban areas. Tree species with thorns might need to be avoided.

9. A root system that grows near the soil surface is characteristic of some trees. The roots can interfere with turf grass.

10. Trees that cast heavy shade inhibit grass growth. If grass growth is desired, select trees, such as, the honeylocust, that allow light to reach the ground.

Objective 1: Identify methods of harvesting trees.

Anticipated Problem: What methods are used to harvest trees?

I. Commercially available trees are propagated sexually or asexually and grown to a saleable size in a nursery. Nursery production might involve planting of young trees in fields or growing young trees in containers. When the trees reach an appropriate size they are harvested for transport in one of three ways.

A. Container grown plants are grown and sold in containers. The containers are most often plastic plant pots. Container grown plants are easy to handle and move. There is little damage to roots, and hence less stress on the tree during planting. Also, container grown trees are available for planting throughout most of the year. Growing trees in containers is especially suitable for evergreen and broadleaf evergreens.

B. Balled and burlapped (B&B) plants are grown “in the field” and are then dug with a soil ball around the roots. The soil ball is then wrapped in burlap or placed in a burlap bag to keep it from falling apart and to provide some root protection. Balling nails are used to hold the burlap in place. Twine is also used to secure the ball or the ball may be placed in metal baskets. Transplanting trees in this manner is a traditional method that has been used successfully for centuries. It is particularly suitable for larger specimens such as large evergreen or woody trees.

C. Bare root (BR) plants are grown “in the field” and are usually harvested when the trees are dormant. Soil is cleaned from the roots, roots are pruned, and the trees stored in a cool place. Care must be taken to prevent the roots of trees harvested in this way from drying out before planting. This method is suitable for many medium or smaller trees. Bare root plants are light weight and therefore, easier to ship than balled and burlapped

Objective 2: Explain recommended tree planting techniques.

Anticipated Problem: What are the recommended tree planting techniques?

II. The following techniques are common ways to plant, supported by the latest research.

A. Balled and burlapped trees are heavy and care should be taken to keep the soil ball intact.

1. Dig the planting hole at least 12” wider than the soil ball. The larger the hole, the better. The hole should be deep enough so the top of the soil ball is level with the surface of the surrounding soil. A plant should never be planted deeper than it was originally. Deep planting limits exchange of soil gases that
can lead to root rot and death. On occasion when the soil is poorly drained or wet, the soil ball can be planted a little higher than the surrounding soil.

2. Once the hole has been checked against the size of the ball for depth, carefully place the plant in the hole with the burlap and twine intact. Handle the plant by the root ball.

3. Once located, remove all twine, particularly if it is nylon twine. Twine can girdle the trunk and roots. Remove burlap as well. At minimum fold brown burlap down into the hole. Exposed burlap can wick water from around the soil ball. Green burlap is treated with preservative and must be removed. Plastic wrap must also be completely removed. Metal cages can remain.

4. Position the plant with the best side facing toward the main viewing point. Position the tree so that it is perpendicular to the ground. Stand back and eye the tree. Holding a spade handle between the thumb and forefinger, letting it hang like a plumb, and lining one eye up with the trunk and the handle is one way to check the straight- ness of the trunk.

5. Once in position, fill the planting hole half way with the same soil that came from the hole. Digging will have loosened it, making it easier for roots to penetrate. Care- fully tap the soil down by stepping on it. This reduces air pockets and the amount of settling that will occur.

6. Fill the hole with water and let it soak into the soil and soil ball.

7. Complete the backfill process. Do not pack the soil by stepping on it.

8. Pile loose soil in a circular mound towards the outside part of the hole. The mound creates a large saucer to hold water. Also as the soil settles over the next year, the mound will diminish. 9. Water the tree by filling the saucer.

10. Staking is performed to hold newly planted trees in place. It is not necessary for most smaller trees. Recent research has shown that unstaked plants grow roots for stability in response to wind, and the trunks are stronger. Medium size trees (over 6’ in height but less than 12’) may need staking to prevent the tree from tilting. When staking a tree, two or three long stakes should be driven into the ground outside the edge of the plant hole. Use wire to attach the stakes to the trunk. The wire should be wrapped to protect the tree’s bark from damage (pieces of old garden hose work well). Larger trees (over 12’ in height) may need guying. Guying is when cables are attached to the tree trunk, which are in turn anchored to three equally spaced ground stakes.

11. Mulch placed within the soil saucer will help to keep the soil moist and reduce weed growth. Some organic mulches include wood chips, pine needles, tree bark chips, shredded corn cobs, cocoa bean hulls, and peat moss. Inorganic mulches come from non-living substances and include such things as gravel, crushed stone, sand, brick chips, and shredded rubber. They are very durable and long lasting. Spread mulches 2 to 4 inches deep.

B. Containerized trees are handle much the same way as balled and burlapped trees.

1. Remove the tree from the container by inverting the plant, tapping the sides on a solid surface to release the plant, and then slide the soil ball out.

2. Check the plant for root circling. Root circling is when the roots have grown around the inside of the pot. If the tree has a mass of roots circling the inside of the container, the trees health may be in jeopardy. In those cases, loosen or
cut the roots with a knife. Then spread them apart before planting. Generally, four or five vertical cuts from the top to the bottom of the soil ball are sufficient.

3. Follow the planting procedures described for balled and burlapped trees.

C. Bare root planting follows the same general guidelines as container grown plants.

   1. Remove any wrapping material from around the plant’s roots and discard.
   2. Dig the hole as deep as the longest root and at least 12” wider than the diameter of the root system.
   3. Determine the depth at which tree should be planted by locating a stain on the bark or stem of a bare root that marks the level of the original field height. The tree or shrub should be planted at the same depth as it was growing in the nursery.
   4. Once the hole has been dug, replace some of the tilled soil at the bottom center to form a cone. Rest the crown on this cone so the tree is at the proper depth. Carefully, spread the secondary roots out over the rest of the hole in their natural shape.
   5. Backfill the hole until the hole half-filled, tamping the soil carefully to remove air pockets. Water and complete the backfilling. From this point follow the procedure as described for balled and burlapped trees.

D. Before the leaves emerge in the spring and in the fall are generally the best times to dig trees. There is less stress on the trees during those periods. However, the best time to dig trees depends largely on the species.

E. Plant trees in the spring when temperatures are cooler, rainfall is abundant, and plants are entering a phase of active growth. Fall is also a good time for transplanting. In either case the trees have an opportunity to establish some root growth before the heat of summer.

Objective 3: Describe post-planting care of trees.

Anticipated Problem: How should trees be cared for after planting?

III. Most trees need little care once they become established. Watering can reduce stress and maintain tree health. Fertilizing can also boost tree health.

A. Water is the single most important factor in the growth and development of a tree.

   1. For newly planted trees it is important to maintain a moist soil. Moisture encourages root development. Roots also need oxygen. Excessive water from poor drainage or watering can frequently fill soil pore spaces and eliminate oxygen. Under these conditions roots can be damaged and die. As a result it is important to monitor the level of soil moisture. In periods of warm dry weather it is advised to thoroughly soak the soil every 10 to 14 days provided the soil is well drained and is approaching dryness.

   2. Established trees benefit from a good soaking of water every 2–3 weeks during periods of drought.

   3. Water can be applied in a variety of ways. It is often enough to simply let water trickle out the end of a garden hose laid at the base of a tree until the soil is well moistened. Sprinklers, soaker hoses, watering bags, microirrigation and soil watering needles can also be used.

B. Most trees never need to be fertilized. They extract the nutrients they need from the soil.
1. Trees that show signs of stress of nutrient deficiency can benefit from fertilizer application. Chlorosis or the yellowing of leaves could be an indication of a nutrient deficiency.

2. The best time to fertilize is in the spring as buds begin to swell and in the fall when the leaves drop. It is important to deliver the fertilizer to the root zone of the tree. The root zone is the area where roots are found, generally within the top 2 feet of soil and 1 and a half times the width of the tree. Fertilizer can be applied by placing dry fertilizer in holes, using dry fertilizer spikes, injecting soluble fertilizer into the soil, broadcasting or spreading fertilizer on the soil surface, spraying soluble fertilizer on foliage, and implanting solid fertilizer in the tree trunk.

Objective 1: Identify reasons for pruning urban trees.

Anticipated Problem: What are the reasons for pruning urban trees?

I. Pruning is the term used for the selective removal or reduction of certain plant parts. Trees are pruned for a variety of reasons. Proper pruning leads to attractive, healthy trees. Some of the reasons for pruning trees include the following:

A. Promote the development of a strong framework of branches.
B. Restrict the size of the plant.
C. Repair damaged limbs.
D. Improve flowering displays.
E. Reduce the spread of pests by removing diseased limbs.
F. Direct the plant’s growth in a particular direction.
G. Maintain desired cultivars.
H. Open the crown to allow for light and wind to pass.
I. Maintain safe conditions for humans.
J. Improve fruit quality.

Objective 2: Describe how to prune trees safely.

Anticipated Problem: What techniques are used to prune trees safely?

II. Approved techniques have been established for pruning trees safely. Make good decisions as to why and how a tree is be pruned before any cut is made. All cuts should contribute to the pruning goals that have been established. It is important to understand the parts of trees, the best times to prune, how trees heal, and how to remove large limbs.

A. Some general rules of pruning should be kept in mind.
   1. Make cuts that will cause the least amount of damage to the tree.
   2. Begin pruning the tree while it is young.
   3. Choose the tools most suitable for the job, keep them sharp, and use them safely.

B. Knowledge of major tree structures and their functions is important.
   1. A leader is a central branch that is dominant over other branches on the tree. It leads the growth of the tree. Co-leaders are not desirable. They are unattractive and lead to the development of weak V-shaped crotches. When co-leaders exist, the less desirable one of the two should be removed.
2. Scaffold branches grow laterally from the trunk. The trees’ weakest point is where scaffold branches attach to the trunk. The angle of attachment to the trunk influences the structural soundness scaffold branches.
   a. U-shaped crotches are created by branches that attach to the trunk at angles of 45° to 90°. These branches are structurally sound due to the wide angle.
   b. V-shaped crotches are created by branches that attach at sharp angles. The joint is weak because the bark is crushed between the branches as the tree grows and expands. Trees with V-shaped crotches are prone to splitting.

3. Watersprouts are soft, green shoots that usually grow vertically from existing branches. If allowed to grow, they may cross and rub against other branches. They should be removed from the tree.

4. Crossing branches are those branches that grow in different directions and make contact with one another. The friction created by the rubbing together of these branches may open wounds. The wounds allow disease and insects to enter. In addition, they are unattractive. Regular removal of branches that are growing towards the tree’s center will eliminate most crossing branches.

5. Suckers are soft, green shoots that develop at the base of the tree. Like watersprouts, suckers are of no ornamental value to the tree. It is particularly important to remove suckers from grafted plants. In grafting, the rootstock (root system) has different qualities than the scion (top growth). If suckers from the rootstock are allowed to grow, they will interfere with the desired ornamental effect of the scion.

6. Dead, diseased, and broken wood should be removed from the tree. Removal of dead and diseased wood reduces the spread of disease. Pruning dead wood also eliminates safety hazards.

C. When to prune relates to the season of the year in which trees are cut and the tree’s stage of maturity at which the pruning is carried out.

1. Late winter and early spring are the best times to prune most deciduous trees. Pruning at that time of year, when trees are dormant, has advantages:
   a. Branching structure is more visible without the presence of leaves.
   b. The limbs are much lighter without leaves.
   c. Tree cuts made at these times of the year give the tree an entire growing season in which to heal.

2. Some trees such as maples, birches, and elms will ooze sap if pruned in the late winter or early spring. Although the sap causes no damage, it is best to prune these types of trees in midsummer when the sap is not flowing.

3. Pruning newly transplanted trees requires special considerations and should be done with restraint. The key to a tree’s survival is its ability to develop a new root system. Removing limbs means the loss of energy from producing leaves and storing starches that contribute to root growth and development. Removal of over 15 percent of the crown at the time of transplanting slows tree growth for several years. Pruning of newly transplanted trees should be restricted to the removal of co-dominant leaders, dead and diseased wood, and V-shaped crotches.

4. A tree’s second pruning should occur two to four years after planting. During the second pruning, crossed branches, limbs that have died back, and some lower
branches are removed. To contribute to a strong trunk, it is best to not remove all of the lower branches at once.

5. The tree should be pruned again five to seven years after planting. The amount to be removed should be minimal.

D. Subordination is an important concept in pruning. Subordination involves cuts made that slow the growth of a branch, and is accomplished by removing lateral branches and/or reducing the length of the parent branch cause the branch to become subordinate or less dominant.
Subordination is used with all tree sizes, and is often most appropriate when multiple leaders on a small tree are involved. Identify the best of the leaders, and prune the others. The pruned branches will grow more slowly than the un-cut branch selected to be the leader. The un-cut branch will emerge as the dominant leader, while the others will become major limbs of the tree.

E. Three basic techniques are used to prune trees. They include drop-crotch cuts, thinning cuts, and heading cuts.
1. Drop-crotch cuts are effectively used to shorten tree limbs and reduce the size of a tree. It involves cutting the leader limb back to a lateral branch. The lateral branch remaining should be at least one-third the diameter of the leader removed.
2. Thinning cuts are those cuts made to remove a branch from the parent stem or trunk. They open up the tree rather than reduce its size. This is the most common pruning method for large, established trees.
3. Heading cuts are made between the nodes on a stem with a hand pruner or lopper. Heading cuts are commonly used with nursery stock.
4. Procedures for removing large limbs should be followed to ensure safety. Large limbs can be very heavy. Such weight will not only injure people, but it can also damage the tree if the limb is not removed properly. Improper removal often strips bark from the tree. Removal of large limbs involves a series of cuts.
   a. Make an undercut about 1/3 of the way through the limb about a foot from the trunk.
   b. Make the second cut the upper side of the limb about 1 inch from the undercut.
      This cut should be made closer to the trunk than the first cut to swing the branch toward the tree before it drops or further from the trunk for the limb to drop without swinging.
   c. Make the final cut closer to the trunk than the previous two. The proper cut is one that is made as close to the branch collar and branch bark ridge as possible without causing damage to those tissues. After the final cut is made, the wound should be left exposed. Sealers are never needed. They promote decay by keeping conditions moist for fungal and bacterial growth.

Objective 3: Explain how trees close their wounds.
Anticipated Problem: How do trees close their wounds?
III. Trees have the ability to close or seal wounds with chemicals that inhibit decay caused by fungi and bacteria. This form of defense is called compartmentalization.

A. At the base of every branch there is a branch bark ridge and a collar. The branch bark ridge is a raised line of bark that forms on the upper side of where the branch joins the bark. The collar is the swollen tissue surrounding the base of the branch. These structures contain chemicals that inhibit the spread of disease. It is important that during the pruning process that the branch bark ridge and collar tissues that defend the tree from infection and decay are not damaged.

B. When a tree is wounded, it begins to form a callus, or protective growth of tissue over the wound. Eventually, the callus growth covers the wound.

Objective 4: Identify tools used in pruning trees.

Anticipated Problem: What tools are used in pruning trees?

IV. There are a number of tools used for pruning purposes. Proper tool selection for the job and safety are primary concerns.

A. Hand pruners are best used on small branches. Loppers are used for somewhat larger branches. The two major styles for both of these tools are scissors and anvil. Scissor style pruners are preferred as the blade slices the plant stem. Anvil style pruners are less desirable as plant stems are crushed when cut.

B. Pruning saws have larger teeth with wider spacing than carpenter’s saws. The large teeth and spacing ease the cutting of larger limbs.

C. Pole saws/pruners are specialty tools that allow a person to reach high limbs from the ground.

D. Chain saws are gas powered or electric and have a chain that cuts continuously. They are best used on large limbs. Chain saws are extremely dangerous if used improperly. To avoid hazards, obtain training on their safe operation. Some safety tips follow:
   1. Study branches before making any cuts.
   2. Accelerate the saw before beginning a cut.
   3. Keep feet completely still while the chain is turning.
   4. Do not use the guide bar’s upper tip for cutting.
   5. If pinching occurs, shut the saw off before extracting the saw blade.
Urban Forestry

Across
2. yellowing of leaves
5. placed around tree to help keep the soil moist
9. cuts made to slow the growth of a branchcallus protective growth of tissue over a wound
10. place where trees are grown to a saleable size
11. B&B
12. grow laterally from the trunk

Down
1. spray to make the tree slow moisture loss
3. culture and care of a tree
4. holds newly planted trees in place
6. central dominant branch
7. plants are grown and sold in containers
8. no soil is present with this tree

12 of 12 words were placed into the puzzle.

Created by Puzzlemaker at DiscoverySchool.com

Urban Forestry Worksheet

1. ______ enhances an arborist's credentials.
2. Air temperature under a large shade tree can be ____ degrees cooler than the temperature in the sun.
3. Benefits from urban forests may be related to the ____________, the ____________, and ____________.
4. Trees serve as barriers by blocking ____________, ____________, and ____________.
5. An acre of trees produces enough oxygen everyday for ____ people.
6. Well-landscaped houses with mature trees can be valued at _____ % more than houses lacking trees.
7. In urban settings trees impact ____________, ____________, ____________, ____________, ____________, and ____________.
8. Research has shown urban forests to be good for ____________.
9. ____________ often contain rules regarding private trees, which pose a hazard to the traveling public.
10. ____________ involve protection for native trees or trees with historical significance.
11. _______ are large trees with spreading canopies.
12. The species is written with ____________ letters.
13. All cultivated trees have common and ____________ names.
14. The ____________ is useful in deciding what trees survive cold temperatures in a particular region in the United States.
15. Resistance to problems associated with ____________ is considered an attribute.
16. The genus is always ____________.
17. A ____________ showing 12 zones in the United States and indicates the number of days in which the temperature exceeds 86 F for each zone.
18. Drainage factors of the soil or _______ of the soil can cause physiological disease.
19. The soils in urban areas are usually altered in that ____________, ____________, ____________, and ____________.
20. Trees that cast heavy shade _______ grass growth.
21. ____________ is performed to hold newly planted trees in place.
22. Stress from water loss can be reduced by spraying tree leaves with an ____________.
23. In periods of warm dry weather it is advised to thoroughly soak the soil around newly planted trees every _______ days provided the soil is well drained and is approaching dryness.
24. A plant should never be planted ____________ than it was originally.
25. __________________ and ________ are generally the best times to dig trees.

26. Plant trees in the ____________ or ____________ when temperatures are cooler, rainfall is abundant, and plants are entering a phase of active growth.

27. _________ burlap is treated with preservative and must be removed.

28. Most trees never need to be ________________.

29. Spread mulches ________________ deep.

30. Established trees benefit from a good soaking of water ______________ during periods of drought.

31. ________________ involves cuts made that slow the growth of a branch, and is accomplished by removing ________________ and/or reducing the length of the ________________ cause the branch to become subordinate or less dominant.

32. Trees have the ability to close or seal wounds with chemicals that inhibit decay caused by fungi and bacteria. This form of defense is called ________________.

33. When co-leaders exist, the less desirable one of the two should be ________________.

34. __________________ are created by branches that attach at sharp angles.

35. ________________ are soft, green shoots that usually grow vertically from existing branches.

36. ________________ and ________________ are the best times to prune most deciduous trees.

37. ________________ are effectively used to shorten tree limbs and reduce the size of a tree. It involves cutting the ________________ back to a lateral branch. The lateral branch remaining should be at least ________________ the diameter of the leader removed.

38. Improper removal of large limbs often ________________.

39. After the final cut is made in removing a limb, the wound should be ________________.

40. At the base of every branch there is a ________________ and ________________. These structures contain chemicals that inhibit the spread of disease.
Appendix D
ENVIRONMENTAL SCIENCE
Course Description

MAY 2008, MAY 2009
The College Board: Connecting Students to College Success

The College Board is a not-for-profit membership association whose mission is to connect students to college success and opportunity. Founded in 1900, the association is composed of more than 5,000 schools, colleges, universities, and other educational organizations. Each year, the College Board serves seven million students and their parents, 23,000 high schools, and 3,500 colleges through major programs and services in college admissions, guidance, assessment, financial aid, enrollment, and teaching and learning. Among its best-known programs are the SAT®, the PSAT/NMSQT®, and the Advanced Placement Program® (AP®). The College Board is committed to the principles of excellence and equity, and that commitment is embodied in all of its programs, services, activities, and concerns.

For further information, visit www.collegeboard.com.

The College Board and the Advanced Placement Program encourage teachers, AP Coordinators, and school administrators to make equitable access a guiding principle for their AP programs. The College Board is committed to the principle that all students deserve an opportunity to participate in rigorous and academically challenging courses and programs. All students who are willing to accept the challenge of a rigorous academic curriculum should be considered for admission to AP courses. The Board encourages the elimination of barriers that restrict access to AP courses for students from ethnic, racial, and socioeconomic groups that have been traditionally underrepresented in the AP Program. Schools should make every effort to ensure that their AP classes reflect the diversity of their student population.

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Visit the College Board on the Web: www.collegeboard.com.
Dear Colleagues:

The College Board has pledged to become a stronger advocate in improving education for America's children. Our nation's college graduation rate is not what it should be and, with your help, we can do something about that. One of the best predictors of college performance is success in an AP® course in high school. A study published by the National Center for Educational Accountability has shown that students who succeed on AP Exams benefit academically with better college graduation rates than their fellows.

In 2006, more than 16,000 schools offered high school students the opportunity to take AP courses, and over 1.3 million students then took the challenging AP Exams. These students felt the power of learning come alive in the classroom, and many earned college credit and placement while still in high school. Behind these students were talented, hardworking teachers who are the heart and soul of the Advanced Placement Program®.

This AP Course Description summarizes the variety of approaches and curricula used in college courses corresponding to the AP course. Teachers have the flexibility to develop their own syllabi and lesson plans, and to bring their individual creativity to the AP classroom. In fact, AP Exams are designed around this flexibility and allow students whose courses vary significantly equal opportunities to demonstrate college-level achievement. Finally, this curricular flexibility is reflected in the AP Course Audit, which identifies elements considered by higher education as essential to a college-level course, providing a consistent standard for disparate AP classes across the world, while not setting forth a mandated AP curriculum.

The College Board is committed to supporting the work of AP teachers. AP workshops and summer institutes, held around the globe, provide stimulating professional development for tens of thousands of teachers each year. The College Board Fellows scholarships provide funds to support many teachers' attendance at these institutes. Teachers and administrators can also visit AP Central, the College Board's online home for AP professionals, at apcentral.collegeboard.com. Here, teachers have access to a growing set of resources, information, and tools, from textbook reviews and lesson plans to electronic discussion groups (EDGs) and the most up-to-date exam information. I invite all teachers, particularly those who are new to the AP Program, to take advantage of these resources.

As we look to the future, the College Board's goal is to broaden access to AP classes while maintaining high academic standards. Reaching this goal will require a lot of hard work. We encourage you to connect students to college and opportunity not only by providing them with the challenges and rewards of rigorous academic programs like AP but also by preparing them in the years leading up to AP courses.

Sincerely,

Gaston Caperton
President
The College Board
Welcome to the AP® Program

The Advanced Placement Program (AP) is a collaborative effort among motivated students; dedicated teachers; and committed high schools, colleges, and universities. Since its inception in 1955, the Program has enabled millions of students to take college-level courses and exams, and to earn college credit or placement, while still in high school.

Most colleges and universities in the United States, as well as colleges and universities in more than 40 other countries, have an AP policy granting incoming students credit, placement, or both on the basis of their AP Exam grades. Many of these institutions grant up to a full year of college credit (sophomore standing) to students who earn a sufficient number of qualifying AP grades.

Each year, an increasing number of parents, students, teachers, high schools, and colleges and universities turn to the AP Program as a model of educational excellence.

More information about the AP Program is available at the back of this Course Description and at AP Central, the College Board's online home for AP professionals (apcentral.collegeboard.com). Students can find more information at the AP student site (www.collegeboard.com/apstudents).

AP Courses

Thirty-seven AP courses in a wide variety of subject areas are available now. A committee of college faculty and master AP teachers designs each AP course to cover the information, skills, and assignments found in the corresponding college course. See page 2 for a complete list of AP courses and exams.

AP Exams

Each AP course has a corresponding exam that participating schools worldwide administer in May (except for AP Studio Art, which is a portfolio assessment). AP Exams contain multiple-choice questions and a free-response section (either essay or problem solving).

AP Exams are a culminating assessment in all AP courses and are thus an integral part of the Program. As a result, many schools foster the expectation that students who enroll in an AP course will take the corresponding AP Exam. Because the College Board is committed to providing access to AP Exams for homeschooled students and students whose schools do not offer AP courses, it does not require students to take an AP course prior to taking an AP Exam.

AP Course Audit

The AP Course Audit was created at the request of secondary school and college and university members of the College Board who sought a means to provide teachers and administrators with clear guidelines on the curricular and resource requirements that must be in place for AP courses. The AP Course Audit also helps colleges and universities better interpret secondary school courses marked “AP” on students’ transcripts. To receive authorization from the College Board to label a course “AP,” schools must demonstrate how their courses meet or exceed these requirements, which colleges and universities expect to see within a college-level curriculum.
The AP Program unequivocally supports the principle that each individual school must develop its own curriculum for courses labeled "AP." Rather than mandating any one curriculum for AP courses, the AP Course Audit instead provides each AP teacher with a set of expectations that college and secondary school faculty nationwide have established for college-level courses. AP teachers are encouraged to develop or maintain their own curriculum that either includes or exceeds each of these expectations; such courses will be authorized to use the "AP" designation. Credit for the success of AP courses belongs to the individual schools and teachers that create powerful, locally designed AP curricula.

Complete information about the AP Course Audit is available at AP Central.

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| **German Language** | |
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AP Environmental Science

INTRODUCTION

The AP Environmental Science course is designed to be the equivalent of a one-semester, introductory college course in environmental science. Unlike most other introductory-level college science courses, environmental science is offered from a wide variety of departments, including geology, biology, environmental studies, environmental science, chemistry, and geography. Depending on the department offering the course, different emphases are placed on various topics. Some courses are rigorous science courses that stress scientific principles and analysis and that often include a laboratory component; other courses emphasize the study of environmental issues from a sociological or political perspective rather than a scientific one. The AP Environmental Science course has been developed to be most like the former; as such, it is intended to enable students to undertake, as first-year college students, a more advanced study of topics in environmental science or, alternatively, to fulfill a basic requirement for a laboratory science and thus free time for taking other courses.

The AP Course Description and AP Exam have been prepared by environmental scientists and educators who serve as members of the AP Environmental Science Development Committee. In both breadth and level of detail, the content of the course reflects what is found in many introductory college courses in environmental science. The exam is representative of such a course and therefore is considered appropriate for the measurement of skills and knowledge in the field of environmental science.

THE COURSE

The goal of the AP Environmental Science course is to provide students with the scientific principles, concepts, and methodologies required to understand the interrelationships of the natural world, to identify and analyze environmental problems both natural and human-made, to evaluate the relative risks associated with these problems, and to examine alternative solutions for resolving or preventing them.

Environmental science is interdisciplinary; it embraces a wide variety of topics from different areas of study. Yet there are several major unifying constructs, or themes, that cut across the many topics included in the study of environmental science. The following themes provide a foundation for the structure of the AP Environmental Science course.

1. Science is a process.
   • Science is a method of learning more about the world.
   • Science constantly changes the way we understand the world.

2. Energy conversions underlie all ecological processes.
   • Energy cannot be created; it must come from somewhere.
   • As energy flows through systems, at each step more of it becomes unusable.
3. The Earth itself is one interconnected system.
   - Natural systems change over time and space.
   - Biogeochemical systems vary in ability to recover from disturbances.

   - Humans have had an impact on the environment for millions of years.
   - Technology and population growth have enabled humans to increase both the rate and scale of their impact on the environment.

5. Environmental problems have a cultural and social context.
   - Understanding the role of cultural, social, and economic factors is vital to the development of solutions.

6. Human survival depends on developing practices that will achieve sustainable systems.
   - A suitable combination of conservation and development is required.
   - Management of common resources is essential.

Prerequisites

The AP Environmental Science course is an excellent option for any interested student who has completed two years of high school laboratory science—one year of life science and one year of physical science (for example, a year of biology and a year of chemistry). Due to the quantitative analysis that is required in the course, students should also have taken at least one year of algebra. Also desirable (but not necessary) is a course in earth science. Because of the prerequisites, AP Environmental Science will usually be taken in either the junior or senior year.

Textbooks

A number of recently published textbooks are appropriate for college students enrolled in introductory courses in environmental science. Reviews of many such textbooks can be found by clicking on the Teachers' Resources tab on the AP Central home page (apcentral.collegeboard.com). The AP Environmental Science teacher should examine a variety of textbooks and use one that will adequately cover the suggested syllabus in a manner and style satisfactory to the teacher and the students. Among the major considerations to be used in choosing a text are depth and breadth of coverage, quality of illustrations, readability, clarity of presentation, value of end-of-chapter questions, availability of other teaching aids, and the capacity to stimulate student interest. A recently published textbook should be chosen so as to ensure that the information it contains is current and accurate.

School systems should recognize that the rapidly changing nature of environmental science requires regular updating of textbooks. While textbooks serve as valuable references, they cannot be exhaustive. Professional development—especially remaining current with new discoveries, events, and conceptual trends—is one responsibility of any AP teacher.
The following outline of major topics serves to describe the scope of the AP Environmental Science course and exam. The Development Committee has reorganized the outline in order to better present the course content in terms of major concept areas. However, it is important to note that this reorganized outline does NOT represent a change in the content of the course or the exam. The order of topics in the outline holds no special significance, since there are many different sequences in which the topics can be appropriately addressed in the course. The percentage after each major topic heading shows the approximate proportion of multiple-choice questions on the exam that pertain to that heading; thus the percentage also indicates the relative emphasis that should be placed on the topics in the course.

I. Earth Systems and Resources (10–15%)
   A. Earth Science Concepts
      (Geologic time scale; plate tectonics, earthquakes, volcanism; seasons; solar intensity and latitude)
   B. The Atmosphere
      (Composition; structure; weather and climate; atmospheric circulation and the Coriolis Effect; atmosphere–ocean interactions; ENSO)
   C. Global Water Resources and Use
      (Freshwater/saltwater; ocean circulation; agricultural, industrial, and domestic use; surface and groundwater issues; global problems; conservation)
   D. Soil and Soil Dynamics
      (Rock cycle; formation; composition; physical and chemical properties; main soil types; erosion and other soil problems; soil conservation)

II. The Living World (10–15%)
   A. Ecosystem Structure
      (Biological populations and communities; ecological niches; interactions among species; keystone species; species diversity and edge effects; major terrestrial and aquatic biomes)
   B. Energy Flow
      (Photosynthesis and cellular respiration; food webs and trophic levels; ecological pyramids)
   C. Ecosystem Diversity
      (Biodiversity; natural selection; evolution; ecosystem services)
   D. Natural Ecosystem Change
      (Climate shifts; species movement; ecological succession)
   E. Natural Biogeochemical Cycles
      (Carbon, nitrogen, phosphorus, sulfur, water, conservation of matter)
III. Population (10–15%)

A. Population Biology Concepts
   (Population ecology; carrying capacity; reproductive strategies; survivorship)

B. Human Population
   1. Human population dynamics
      (Historical population sizes; distribution; fertility rates; growth rates and
doubling times; demographic transition; age-structure diagrams)
   2. Population size
      (Strategies for sustainability; case studies; national policies)
   3. Impacts of population growth
      (Hunger; disease; economic effects; resource use; habitat destruction)

IV. Land and Water Use (10–15%)

A. Agriculture
   1. Feeding a growing population
      (Human nutritional requirements; types of agriculture; Green Revolution;
genetic engineering and crop production; deforestation; irrigation; sus-
tainable agriculture)
   2. Controlling pests
      (Types of pesticides; costs and benefits of pesticide use; integrated pest
management; relevant laws)

B. Forestry
   (Tree plantations; old growth forests; forest fires; forest management;
national forests)

C. Rangelands
   (Overgrazing; deforestation; desertification; rangeland management; federal
rangelands)

D. Other Land Use
   1. Urban land development
      (Planned development; suburban sprawl; urbanization)
   2. Transportation infrastructure
      (Federal highway system; canals and channels; roadless areas; ecosystem
impacts)
   3. Public and federal lands
      (Management; wilderness areas; national parks; wildlife refuges; forests;
wetlands)
   4. Land conservation options
      (Preservation; remediation; mitigation; restoration)
   5. Sustainable land-use strategies

E. Mining
   (Mineral formation; extraction; global reserves; relevant laws and treaties)
F. Fishing
   (Fishing techniques; overfishing; aquaculture; relevant laws and treaties)

G. Global Economics
   (Globalization; World Bank; Tragedy of the Commons; relevant laws and treaties)

V. Energy Resources and Consumption (10–15%)
   A. Energy Concepts
      (Energy forms; power; units; conversions; Laws of Thermodynamics)
   B. Energy Consumption
      1. History
         (Industrial Revolution; exponential growth; energy crisis)
      2. Present global energy use
      3. Future energy needs
   C. Fossil Fuel Resources and Use
      (Formation of coal, oil, and natural gas; extraction/purification methods; world reserves and global demand; synfuels; environmental advantages/disadvantages of sources)
   D. Nuclear Energy
      (Nuclear fission process; nuclear fuel; electricity production; nuclear reactor types; environmental advantages/disadvantages; safety issues; radiation and human health; radioactive wastes; nuclear fusion)
   E. Hydroelectric Power
      (Dams; flood control; salmon; silting; other impacts)
   F. Energy Conservation
      (Energy efficiency; CAFE standards; hybrid electric vehicles; mass transit)
   G. Renewable Energy
      (Solar energy; solar electricity; hydrogen fuel cells; biomass; wind energy; small-scale hydroelectric; ocean waves and tidal energy; geothermal; environmental advantages/disadvantages)

VI. Pollution (25–30%)
   A. Pollution Types
      1. Air pollution
         (Sources—primary and secondary; major air pollutants; measurement units; smog; acid deposition—causes and effects; heat islands and temperature inversions; indoor air pollution; remediation and reduction strategies; Clean Air Act and other relevant laws)
      2. Noise pollution
         (Sources; effects; control measures)
      3. Water pollution
         (Types; sources, causes, and effects; cultural eutrophication; groundwater pollution; maintaining water quality; water purification; sewage treatment/septic systems; Clean Water Act and other relevant laws)
4. Solid waste
   (Types; disposal; reduction)

B. Impacts on the Environment and Human Health
1. Hazards to human health
   (Environmental risk analysis; acute and chronic effects; dose-response relationships; air pollutants; smoking and other risks)
2. Hazardous chemicals in the environment
   (Types of hazardous waste; treatment/disposal of hazardous waste; cleanup of contaminated sites; biomagnification; relevant laws)

C. Economic Impacts
   (Cost-benefit analysis; externalities; marginal costs; sustainability)

VII. Global Change (10–15%)

A. Stratospheric Ozone
   (Formation of stratospheric ozone; ultraviolet radiation; causes of ozone depletion; effects of ozone depletion; strategies for reducing ozone depletion; relevant laws and treaties)

B. Global Warming
   (Greenhouse gases and the greenhouse effect; impacts and consequences of global warming; reducing climate change; relevant laws and treaties)

C. Loss of Biodiversity
   1. Habitat loss; overuse; pollution; introduced species; endangered and extinct species
   2. Maintenance through conservation
   3. Relevant laws and treaties

LABORATORY AND FIELD INVESTIGATION

Because it is designed to be a course in environmental science rather than environmental studies, the AP Environmental Science course must include a strong laboratory and field investigation component. The goal of this component is to complement the classroom portion of the course by allowing students to learn about the environment through firsthand observation. Experiences both in the laboratory and in the field provide students with important opportunities to test concepts and principles that are introduced in the classroom, explore specific problems with a depth not easily achieved otherwise, and gain an awareness of the importance of confounding variables that exist in the “real world.” In these experiences students can employ alternative learning styles to reinforce fundamental concepts and principles. Because all students have a stake in the future of their environment, such activities can motivate students to study environmental science in greater depth. Colleges often require students to present their laboratory materials from AP science courses before granting college credit for laboratory, so students should be encouraged to retain their laboratory notebooks, reports, and other materials.
Laboratory and field investigation activities in the course should be diverse. As examples, students can acquire skills in specific techniques and procedures (such as collecting and analyzing water samples), conduct a long-term study of some local system or environmental problem (such as the pollution of a nearby stream), analyze a real data set (such as mean global temperatures over the past 100 years), and visit a local public facility (such as a water-treatment plant).

Although there is a great diversity in the laboratory and field activities that would be appropriate for the course, activities should:

- always be linked to a major concept in science and to one or more areas of the course outline
- allow students to have direct experience with an organism or system in the environment
- involve observation of phenomena or systems, the collection and analysis of data and/or other information, and the communication of observations and/or results

The relative magnitudes of these elements may vary from activity to activity. As a whole, the course’s laboratory and field investigation component should encompass all of the elements.

The laboratory and field investigation component of the AP Environmental Science course should challenge the students’ abilities to:

- critically observe environmental systems
- develop and conduct well-designed experiments
- utilize appropriate techniques and instrumentation
- analyze and interpret data, including appropriate statistical and graphical presentations
- think analytically and apply concepts to the solution of environmental problems
- make conclusions and evaluate their quality and validity
- propose further questions for study
- communicate accurately and meaningfully about observations and conclusions

It is expected that students will perform as many labs/field investigations as possible; these investigations should fulfill the criteria outlined above. There are no specific AP Environmental Science classroom labs or field investigations required for the course; thus teachers have greater flexibility when it comes to the types of labs, field investigations, and field trips that are undertaken in their courses. Depending on location, students could perform water tests on a freshwater pond, a river, or an estuary/marine environment. Every teacher should provide students with opportunities to perform experiments and analyses involving the study of air, water, and soil qualities as an essential core for the lab/field investigation activities.

The AP Environmental Science Teacher’s Guide provides many resources for lab/field investigation activities from both college and high school AP teachers. This publication is available in the College Board Store at AP Central (store.collegeboard.com). AP Central and the Environmental Literacy Council (enviroliteracy.org) also
have a collection of inquiry-based environmental science labs and field investigations that have been produced by a group of college and high school teachers and that are suitable for an AP Environmental Science course. In addition, ideas for labs and other activities can be exchanged on the moderated AP Environmental Science electronic discussion group (EDG) for teachers on AP Central.

**INSTRUCTIONAL ISSUES: TRAINING, FUNDING, AND SCHEDULING**

An AP course is a college course, and the resources and time allotted should be similar to those in a college course. Because AP Environmental Science includes substantial material from both the life sciences and the physical sciences, it is likely that many schools will not have a single teacher whose background is adequate preparation to teach the entire course. In these situations, teachers should seek the expertise of their colleagues, by either team teaching, using guest lecturers, or having frequent consultations with colleagues and outside experts.

School administrators should be aware that an AP college-level science course is significantly more expensive to operate than a typical high school course and requires more scheduled time than courses without laboratory work. The introductory-level college science course typically consists of between 40 and 50 hours of lecture and between 30 and 40 hours of laboratory work per quarter or semester. Proportional allocations of time for class and laboratory work should be accorded to an AP Environmental Science course. School administrators should provide the equivalent of two double periods a week to allow for laboratory/field work.

Some of the laboratory/field investigations will require equipment the school may not already have. Schools may find it possible to share equipment that belongs to other high schools or to community colleges but should plan to purchase college-level laboratory equipment eventually.

**THE EXAM**

The AP Environmental Science Exam is three hours long and is divided equally in time between a multiple-choice section and a free-response section. The multiple-choice section, which constitutes 60 percent of the final grade, consists of 100 multiple-choice questions that are designed to cover the breadth of the students' knowledge and understanding of environmental science. Thought-provoking problems and questions based on fundamental ideas from environmental science are included along with questions based on the recall of basic facts and major concepts. The number of multiple-choice questions taken from each major topic area is reflected in the percentage of the course as designated in the topic outline (see pages 5–8).

The free-response section emphasizes the application of principles in greater depth. In this section, students must organize answers to broad questions, thereby demonstrating reasoning and analytical skills, as well as the ability to synthesize material from several sources into cogent and coherent essays. Four free-response questions are included in this section, which constitutes 40 percent of the final grade: 1 data-set question, 1 document-based question, and 2 synthesis and evaluation questions. Questions from the 2006 exam appear on pages 16–19.
To provide maximum information about differences in students' achievements in environmental science, the exam is designed to yield average scores of about 50 percent of the maximum possible scores for both the multiple-choice and free-response sections. Thus, students should be aware that they may find the AP Exam more difficult than most classroom exams. However, it is possible for students who have studied most but not all topics in the outline to obtain acceptable grades.

The use of calculators is not allowed on either section of the exam.

**Sample Multiple-Choice Questions**

The following are examples of the kinds of multiple-choice questions found on the AP Environmental Science Exam. Students should spend an average time of less than 1 minute on each multiple-choice question, since 90 minutes are allotted for answering 100 questions.

Students often ask whether they should guess on multiple-choice questions. Haphazard or random guessing is unlikely to improve scores because one-fourth of the number of questions answered incorrectly will be subtracted from the number of questions answered correctly. However, candidates who have some knowledge of a question and can eliminate one or more answer choices will usually find it advantageous to guess from among the remaining choices. An answer key to the multiple-choice questions can be found on page 15.

**Directions:** The lettered choices on the graph below refer to the numbered statements immediately following it. Select the one lettered choice that best fits each statement. Each choice may be used once, more than once, or not at all in each set.

**Questions 1–3** refer to the lettered points of the curves plotted on the graph below. The curves show two possible patterns of change in population size over time for a certain species of small mammal in an ecosystem.

![Graph of population size over time](graph.png)

1. Population growing exponentially

2. Population decreasing at greatest rate

3. Population growing at a decreasing rate
Sample Questions for Environmental Science

**Directions:** Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select the one that is best in each case.

4. Which of the following is LEAST likely to be an effect of global warming?
   (A) Loss of fertile delta regions for agriculture
   (B) Change in global patterns of precipitation
   (C) Extinction of some species that have narrow temperature requirements
   (D) Decreased rate of photosynthesis in vegetation
   (E) Increased frequency of hurricanes

5. When $X$ joules of nuclear energy is used to produce $Y$ joules of electrical energy, which of the following is true?
   (A) In every case, $X > Y$
   (B) In every case, $X = Y$
   (C) In every case, $X < Y$
   (D) Either $X < Y$ or $X > Y$, depending on the efficiency of the generator
   (E) Either $X < Y$ or $X > Y$, depending on the amount of heat produced
6. A point source discharges organic waste into a stream. Which of the following graphs best depicts the expected pattern for dissolved oxygen (DO) in this stream as a function of distance from the discharge point?

(A) 

(B) 

(C) 

(D) 

(E)
7. Of the following, which has the greatest permeability?
   (A) Clay
   (B) Loam
   (C) Sand
   (D) Silt
   (E) Humus

8. Reasons that the population size of an exotic species often grows rapidly when the species is introduced in a new environment include which of the following?
   I. The exotic species is resistant to pesticides.
   II. There is a large, underutilized food source in the new environment.
   III. The exotic species has few natural predators in the new environment.
   (A) I only
   (B) II only
   (C) I and III only
   (D) II and III only
   (E) I, II, and III

9. Most of the Earth's deserts are at approximately 30° latitude, north and south, because these latitudes are characterized by
   (A) generally warm ocean currents
   (B) predominantly low atmospheric pressure
   (C) descending dry air currents
   (D) slow-moving jet streams
   (E) enhanced solar radiation

10. The presence of which of the following contaminants would be the strongest reason for judging municipal sewage sludge unfit for use as fertilizer?
    (A) Human feces
    (B) Ammonia
    (C) Phosphates
    (D) Nitrates
    (E) Heavy metals

11. Which of the following is the best example of environmental remediation?
    (A) A species of trout becomes extinct in a eutrophic lake.
    (B) The annual volume of sewage flowing into a stream is decreased by one half.
    (C) The height of a factory smokestack is increased.
    (D) A parcel of forest land is declared a state park.
    (E) PCB-consuming bacteria are sprayed on an area that has soil contaminated with PCB's.

12. The CITES treaty has been helpful in protecting endangered animals and plants by
    (A) listing all species that can be hunted, traded, and used commercially
    (B) listing those species and products whose international trade is controlled
    (C) funding projects for breeding endangered plants and animals
    (D) preventing the hunting of whales and dolphins
    (E) specifying prices for certain plant and animal products
Sample Questions for Environmental Science

13. A country currently has a population of 100 million and an annual growth rate of 3.5 percent. If the growth rate remains constant, what will be the population of this country in 40 years?
   (a) 150 million
   (b) 200 million
   (c) 300 million
   (d) 400 million
   (e) 800 million

14. The dangers of disposing of toxic chemicals underground came to public attention in which of the following locations?
   (a) Bhopal, India
   (b) Chernobyl, Ukraine
   (c) Love Canal, New York
   (d) Minamata, Japan
   (e) Three Mile Island, Pennsylvania

15. Which type of electricity-generating power plant releases radioactive materials as well as toxic metals such as lead and arsenic under normal operating conditions?
   (a) Nuclear
   (b) Hydroelectric
   (c) Solar
   (d) Coal-burning
   (e) Geothermal

16. Which of the following greenhouse gases has the greatest heat-trapping ability per molecule?
   (a) Carbon dioxide
   (b) Carbon monoxide
   (c) Chlorofluorocarbon
   (d) Methane
   (e) Nitrous oxide

17. Of the following, the greatest threat to populations of migratory North American songbirds is
   (a) predation by raptors
   (b) clearing of tropical forests
   (c) disease from polluted waters
   (d) sport hunting
   (e) international trade in pets

Answers to Multiple-Choice Questions

<table>
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<tr>
<th>Question</th>
<th>Answer</th>
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Sample Questions for Environmental Science

Sample Free-Response Questions

The free-response section of the exam consists of four required questions: one dataset question, one document-based question, and two synthesis and evaluation questions. The following questions appeared on the 2006 exam. Additional sample questions can be found at AP Central.

1. Upon receiving notice from their electric utility that customers with solar power systems are permitted to sell excess power back to the utility, an Arizona family is considering the purchase of a photovoltaic solar energy system for their 2,700-square-foot suburban home. The initial costs of the systems they are considering range from $7,000 to $30,000. While gathering information prior to making a decision, the homeowners find the following information at the Web site of the United States Department of Energy.

<table>
<thead>
<tr>
<th>Stand-Alone vs. Grid-Connected Systems</th>
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<tr>
<td>Stand-alone systems produce power independently of the utility grid. In some off-the-grid locations as near as one-quarter mile from the power lines, stand-alone photovoltaic systems can be more cost-effective than extending power lines. Direct-coupled systems need no electrical storage because they operate only during daylight hours, but most systems rely on battery storage so that energy produced during the day can be used at night. Some systems, called hybrid systems, combine solar power with additional power sources such as wind or diesel.</td>
</tr>
<tr>
<td>Grid-connected photovoltaic systems supply surplus power back through the grid to the utility and take from the utility grid when the home system’s power supply is low. These systems remove the need for battery storage, although arranging for the grid interconnection can be difficult. In some cases, utilities allow net metering, which allows the owner to sell excess power back to the utility.</td>
</tr>
</tbody>
</table>

(a) Describe one environmental benefit and one environmental cost of photovoltaic systems.

(b) From the two types of solar systems described on the government Web site, select the system (either stand-alone or grid-connected) that you think best meets the needs of the homeowners. Write an argument to persuade them to purchase the system you selected. Include the pros and cons of each system in your argument.

(c) Describe TWO ways that government or industry could promote the use of photovoltaic power systems for homeowners in the future.

(d) Describe TWO ways that homeowners could use passive solar designs and/or systems and, for each way, explain how it would reduce the homeowners’ energy costs.
2. According to atmospheric temperature and CO$_2$ concentration records derived from Antarctic ice cores, Earth's climate has undergone significant changes over the past 200,000 years. Two graphs are shown below. The upper graph shows the variation in atmospheric CO$_2$ concentration, and the lower graph shows the variation in air temperature. Both graphs cover the same time period from approximately 200,000 years ago up until the year 1950, which is represented as year 0 on the graphs.

(a) Answer the following questions that relate to the graphs above. Remember that for any calculations you must clearly indicate how you arrived at your answer. Answers must also include appropriate units.

(i) Determine the net change in atmospheric CO$_2$ concentration between 140,000 years ago and 125,000 years ago.

(ii) Calculate the ratio of the change in mean global temperature to the change in atmospheric CO$_2$ concentration between 140,000 years ago and 125,000 years ago.

(iii) Scientists predict that between 1950 and 2050, the atmospheric CO$_2$ concentration will increase by 200 ppm. Predict the change in mean global temperature between 1950 and 2050 using the ratio that you calculated in part (ii).

(iv) Describe one major assumption that was necessary to make the prediction in part (iii) above. Discuss the validity of the assumption.
Sample Questions for **Environmental Science**

(b) Identify and describe TWO major causes for the predicted 200 ppm increase in atmospheric CO$_2$ concentration between 1950 and 2050.

(c) Identify TWO gases other than CO$_2$ that contribute to the anthropogenic increase in mean global temperature. For each gas, describe a major human activity that leads to its release.

3. The city of Fremont has a large brownfield located along the Fremont River. The brownfield is a former industrial site where contamination by hazardous chemicals impedes redevelopment. The city council is considering two options for reclaiming the brownfield. The first option is to excavate and remove the contaminated soil, and the second option is to decontaminate the soil on the site using vegetation.

(a) Assume that the city council chooses the first option. Describe TWO problems that result from removing the contaminated soil from the brownfield.

(b) Assume that the city council chooses the second option. Explain how vegetation could be used to decontaminate the soil. Discuss one advantage and one disadvantage of using this reclamation method.

(c) Describe and explain one environmental benefit and one societal benefit of brownfield reclamation.

(d) Identify and describe

(i) one method currently used to reduce the production of hazardous waste and

(ii) one method of legally disposing of hazardous waste.
4. The graph above shows the decline in the catch of groundfish (such as cod, haddock, and flounder) from Georges Bank from 1965 to 1995. This decline in the fish harvest resulted in the closure of large portions of the fishery.

(a) Identify the five-year period during which the greatest rate of decline in the fish harvest took place. For that five-year period, calculate the rate of decline in the fish harvest, in metric tons per year. Show clearly how you determined your answer.

(b) Choose any TWO commercial fishing practices from the list below. For each of your choices, describe the practice and explain the role it plays in the depletion of marine organisms.

- Bottom trawling
- Long-line fishing
- Using drift nets/gill nets/purse seines
- Using sonar

(c) Identify one international regulation or United States federal law that applies to the harvesting of marine food resources and explain how that regulation or law helps to manage marine species.

(d) The oceans of the world are often referred to as a commons. Give an example of one other such commons, explain how human activities affect that commons, and suggest one practical method for managing that commons.
AP® Program Essentials

The AP Reading

Each year in June, the free-response section of the exams, as well as the AP Studio Art portfolios, are scored by college faculty and secondary school AP teachers at the AP Reading. Thousands of Readers participate, under the direction of a Chief Reader (a college professor) in each AP subject. The experience offers both significant professional development and the opportunity to network with like-minded educators.

If you are an AP teacher or a college faculty member and would like to serve as a Reader, you can apply online at apcentral.collegeboard.com/readers. Alternatively, you can send an e-mail to apreader@ets.org or call Performance Assessment Scoring Services at 609 406-5384.

AP Grades

The Readers' scores on the essay and problem-solving questions are combined with the results of the computer-scored multiple-choice questions, and the total raw scores are converted to a composite score on AP’s 5-point scale:

<table>
<thead>
<tr>
<th>AP GRADE</th>
<th>QUALIFICATION</th>
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<td>5</td>
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<td>2</td>
<td>Possibly qualified</td>
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<tr>
<td>1</td>
<td>No recommendation</td>
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</tbody>
</table>

Grade Distributions

Many teachers want to compare their students' grades with national percentiles. Grade distribution charts are available at AP Central, as is information on how the grade boundaries for each AP grade are established. Grade distribution charts are also available on the AP student site at www.collegeboard.com/apstudents.

Why Colleges Grant Credit, Placement, or Both for AP Grades

Colleges know that the AP grades of incoming students represent a level of achievement equivalent to that of students who take the same course in the colleges' own classrooms. That equivalency is ensured through several AP Program processes:

- College faculty serve on the committees that develop the Course Descriptions and exams in each AP course.
- College faculty are responsible for standard setting and are involved in the evaluation of student responses at the AP Reading.
- AP courses and exams are reviewed and updated regularly based on the results of curriculum surveys at up to 200 colleges and universities, collaborations among the College Board and key educational and disciplinary organizations, and the interactions of committee members with professional organizations in their discipline.

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• Periodic college comparability studies are undertaken in which the performance of college students on AP Exams is compared with that of AP students to confirm that the AP grade scale of 1 to 5 is properly aligned with current college standards.

In addition, the College Board has commissioned studies that use a “bottom-line” approach to validating AP Exam grades by comparing the achievement of AP students with non-AP students in higher level college courses. For example, in the 1998 Morgan and Ramist “21-College” study, AP students who were exempted from introductory courses and who completed a higher level course in college compared favorably, on the basis of their college grades, with students who completed the prerequisite first course in college, then took the second, higher level course in the subject area. Such studies answer the question of greatest concern to colleges: Are AP students who are exempted from introductory courses as well prepared to continue in a subject area as students who took their first course in college? To see the results of several college validity studies, visit apcentral.collegeboard.com/colleges/research. (The complete Morgan and Ramist study can be downloaded from the site.)

Guidelines on Setting Credit and Placement Policies for AP Grades

The College Board has created two useful resources for admissions administrators and academic faculty who need guidance on setting an AP policy for their college or university. The printed guide AP and Higher Education provides guidance for colleges and universities in setting AP credit and placement policies. The booklet details how to set an AP policy, summarizes AP research studies, and describes in detail course and exam development and the exam scoring process. AP Central has a section geared toward colleges and universities that provides similar information and additional resources, including links to all AP research studies, Released Exam questions, and sample student responses at varying levels of achievement for each AP Exam. Visit apcentral.collegeboard.com/highered.

The Advanced Placement Policy Guide for each AP subject is designed for college faculty responsible for setting their department’s AP policy. These folios provide content specific to each AP Exam, including validity research studies and a description of the AP course curriculum. Ordering information for these and other publications can be found in the AP Publications and Other Resources section of this Course Description.

College and University AP Credit and Placement Policies

Each college and university sets its own AP credit and placement policies. The AP Program has created an online search tool, AP Credit Policy Info, that provides links to credit and placement policies at hundreds of colleges and universities. The tool helps students find the credit hours and advanced placement they can receive for qualifying exam scores within each AP subject. AP Credit Policy Info is available at www.collegeboard.com/ap/creditpolicy.

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AP Scholar Awards

The AP Program offers a number of AP Scholar Awards to recognize high school students who have demonstrated college-level achievement through consistently high performance on AP Exams. Although there is no monetary award, students receive an award certificate, and the achievement is acknowledged on grade reports sent to colleges following the announcement of the awards. For detailed information about AP Scholar Awards (including qualification criteria), visit AP Central or contact the College Board's national office. Students can find this information at www.collegeboard.com/apstudents.

AP Calendar

The AP Program Guide for education professionals and the Bulletin for AP Students and Parents provide important Program information and details on the key events in the AP calendar. Information on ordering or downloading these publications can be found at the back of this book.

Exam Security

All parts of every AP Exam must be kept secure at all times. Forty-eight hours after the exam has been administered, the inserts containing the free-response questions (Section II) can be made available for teacher and student review.* However, the multiple-choice section (Section I) must remain secure both before and after the exam administration. No one other than students taking the exam can ever have access to or see the questions contained in Section I—this includes AP Coordinators and all teachers. The multiple-choice section must never be shared, copied in any manner, or reconstructed by teachers and students after the exam. Schools that knowingly or unknowingly violate these policies will not be permitted to administer AP Exams in the future and may be held responsible for any damages or losses the College Board and/or ETS incur in the event of a security breach.

Selected multiple-choice questions are reused from year to year to provide an essential method of establishing high exam reliability, controlled levels of difficulty, and comparability with earlier exams. These goals can be attained only when the multiple-choice questions remain secure. This is why teachers cannot view the questions, and students cannot share information about these questions with anyone following the exam administration.

To ensure that all students have an equal opportunity to demonstrate their abilities on the exam, AP Exams must be administered in a uniform manner. It is extremely important to follow the administration schedule and all procedures outlined in detail in the most recent AP Coordinator's Manual. Please note that AP Studio Art portfolios and their contents are not considered secure testing materials; see the AP Coordinator's Manual and the appropriate AP Examination Instructions book for further information. The Manual also includes directions on how to handle misconduct and other security problems. All schools participating in AP automatically

*The free-response section of the alternate form (used for late testing administration) is NOT released.
receive printed copies of the Manual. It is also available in PDF format at apcentral.collegeboard.com/coordinators. Any breach of security should be reported to the Office of Testing Integrity immediately (call 800 353-8570 or 609 406-5427, fax 609 406-9709, or e-mail tsreturns@ets.org).

Teacher Support

AP Central® (apcentral.collegeboard.com)
You can find the following Web resources at AP Central (free registration required):

- AP Course Descriptions, AP Exam questions and scoring guidelines, sample syllabi, research reports, and feature articles.
- A searchable Institutes and Workshops database, providing information about professional development events. AP Central offers online events that participants can access from their home or school computers.
- The Course Home Pages (apcentral.collegeboard.com/coursehomepages), which contain insightful articles, teaching tips, activities, lab ideas, and other course-specific content contributed by colleagues in the AP community.
- In-depth FAQs, including brief responses to frequently asked questions about AP courses and exams, the AP Program, and other topics of interest.
- Links to AP publications and products (some available for immediate download) that can be purchased online at the College Board Store (store.collegeboard.com).
- Moderated electronic discussion groups (EDGs) for each AP course to facilitate the exchange of ideas and practices.
- Teachers' Resources database—click on the “Teachers' Resources” tab to search for reviews of textbooks, reference books, documents, Web sites, software, videos, and more. College and high school faculty write the reviews with specific reference to the value of the resources in teaching AP courses.

Online Workshops and Events
College Board online events and workshops are designed to help support and expand the high level of professional development currently offered to teachers in Pre-AP and AP workshops and AP Summer Institutes. Because of budgetary, geographical, and time constraints, not all teachers and administrators are able to take advantage of live, face-to-face workshops. The College Board develops and offers both standard and customized online events and workshops for schools, districts, and states in both live and recorded formats. Online events and workshops are developed and presented by experienced College Board consultants and college faculty. Full-day online workshops are equivalent to one-day, face-to-face workshops and participants can earn CEU credits. For more information, visit apcentral.collegeboard.com/onlineevents.
Pre-AP®

Pre-AP® is a suite of K-12 professional development resources and services designed to help equip middle school and high school teachers with the strategies and tools they need to engage their students in high-level learning, thereby ensuring that every middle school and high school student has the opportunity to acquire a deep understanding of the skills, habits of mind, and concepts they need to succeed in college.

Pre-AP is based on the following premises. The first is the expectation that all students can perform at rigorous academic levels. This expectation should be reflected in the curriculum and instruction throughout the school so that all students are consistently being challenged to bring their knowledge and skills to the next level.

The second important premise of Pre-AP is the belief that educators can prepare every student for higher intellectual engagement by starting the development of skills and the acquisition of knowledge as early as possible. When addressed effectively, the middle school and high school years can provide a powerful opportunity to help all students acquire the knowledge, concepts, and skills needed to engage in a higher level of learning.

Pre-AP teacher professional development explicitly supports the goal of college as an option for every student. It is important to have a recognized standard for college-level academic work. The AP Program provides these standards for Pre-AP. Pre-AP professional development resources reflect the topics, concepts, and skills taught in AP courses and assessed in AP Exams.

The College Board does not design, develop, or assess courses or examinations labeled "Pre-AP." The College Board discourages the labeling of courses as "Pre-AP." Typically, such courses create a track, thereby limiting access to AP classes. The College Board supports the assertion that all students should have access to preparation for AP and other challenging courses. Courses labeled "Pre-AP" can inappropriately restrict access to AP and other college-level work and, as such, are inconsistent with the fundamental purpose of the College Board's Pre-AP initiatives.

Pre-AP Professional Development

Pre-AP professional development is available through workshops and conferences coordinated by the College Board's regional offices. Pre-AP professional development is divided into three categories:

1. **Vertical Teaming**—Articulation of content and pedagogy across the middle school and high school years. The emphasis is on aligning curricula and improving teacher communication. The intended outcome is a coordinated program of teaching skills and concepts over several years.

2. **Classroom Strategies**—Content-specific classroom strategies for middle school and high school teachers. Various approaches, techniques, and ideas are emphasized.
3. **Instructional Leadership**—Administrators and other instructional leaders examine how to use Pre-AP professional development—especially AP Vertical Teams®—to create a system that challenges all students to perform at rigorous academic levels.

For a complete list of Pre-AP professional development offerings, please contact your regional office or visit apcentral.collegeboard.com/pre-ap.

**AP Publications and Other Resources**

A number of AP resources are available to help students, parents, AP Coordinators, and high school and college faculty learn more about the AP Program and its courses and exams. To identify resources that may be of particular use to you, refer to the following key.

- **AP Coordinators and Administrators**
- **College Faculty**
- **Students and Parents**
- **Teachers**

**Free Resources**

Copies of the following items can be ordered free of charge at apcentral.collegeboard.com/freepubs. Items marked with a computer mouse icon 🌐 can be downloaded for free from AP Central.

- 🌐 **The Value of AP Courses and Exams**
  - This brochure, available in English and Spanish, can be used by school counselors and administrators to provide parents and students with information about the many benefits of participation in AP courses and exams.

- **AP Tools for Schools Resource Kit**
  - This complimentary resource assists schools in building their AP programs. The kit includes the video *Experience College Success*, the brochure *The Value of AP Courses and Exams*, and brief descriptions of the AP Credit Policy Info search tool and the Parent’s Night PowerPoint presentation.

  *Experience College Success* is a six-minute video that provides a short overview of the AP Program, with commentary from admissions officers, college students, and high school faculty about the benefits of participation in AP courses. Each videotape includes both an English and Spanish version.

- 🌐 **Bulletin for AP Students and Parents**
  - This bulletin provides a general description of the AP Program, including information on the policies and procedures related to taking the exams. It describes each AP Exam, lists the advantages of taking the exams, describes the grade reporting process, and includes the upcoming exam schedule. The *Bulletin* is available in both English and Spanish.
Get with the Program

All students, especially those from underserved backgrounds, should understand the value of a high-quality education. Written especially for students and their families, this bilingual (Spanish/English) brochure highlights the benefits of participation in the AP Program. (The brochure can be ordered in large quantities for students in grades 8–12.)

AP Program Guide

This guide takes the AP Coordinator through the school year step-by-step—organizing an AP program, ordering and administering the AP Exams, AP Exam payment, and grade reporting. It also includes information on teacher professional development, AP resources, and exam schedules.

AP and Higher Education

This publication is intended to inform and help educational professionals at the secondary and postsecondary levels understand the benefits of having a coherent, equitable AP credit and placement policy. Topics included are development of AP courses and exams, grading of AP Exams, exam validation, research studies comparing the performance of AP students with non-AP students, uses of AP Exams by students in college, and how faculty can get involved in the AP Program.

Advanced Placement Policy Guides

These policy guides are designed for college faculty responsible for setting their department's AP policy, and provide, in a subject-specific context, information about AP validity studies, college faculty involvement, and AP course curricular content. There are separate guides for each AP subject field.

Priced Publications

The following items can be ordered through the College Board Store at store.collegeboard.com. Alternatively, you can download an AP Order Form from AP Central at apcentral.collegeboard.com/documentlibrary.

Course Descriptions

Course Descriptions are available for each AP subject. They provide an outline of each AP course's content, explain the kinds of skills students are expected to demonstrate in the corresponding introductory college-level course, and describe the AP Exam. Sample multiple-choice questions with an answer key and sample free-response questions are included.

Note: PDF versions of current AP Course Descriptions for each AP subject may be downloaded free of charge from AP Central and the College Board's Web site for students. Follow the above instructions to purchase printed copies. (The Course Description for AP Computer Science is available in electronic format only.)
Released Exams

Periodically the AP Program releases a complete copy of each exam. In addition to providing the multiple-choice questions and answers, the publication describes the process of scoring the free-response questions and includes examples of students' actual responses, the scoring standards, and commentary that explains why the responses received the scores they did.

Teacher's Guides

For those about to teach an AP course for the first time, or for experienced AP teachers who would like to get some fresh ideas for the classroom, the Teacher's Guide is an excellent resource. Each Teacher's Guide contains syllabi developed by high school teachers currently teaching the AP course and college faculty who teach the equivalent course at colleges and universities. Along with detailed course outlines and innovative teaching tips, you'll also find extensive lists of suggested teaching resources.

AP Vertical Team Guides


Multimedia

APCD* (home version), (multinetwork site license)

These CD-ROMs are available for AP Calculus AB, AP English Literature, AP European History, and AP U.S. History. They each include actual AP Exams, interactive tutorials, exam descriptions, answers to frequently asked questions, and test-taking strategies. Also included are a listing of resources for further study and a planner to help students schedule and organize their study time.

The teacher version of each CD, which can be licensed for up to 50 workstations, enables you to monitor student progress and provide individual feedback. Included is a Teacher's Manual that gives full explanations along with suggestions for utilizing the APCD in the classroom.
**Electronic Publications**

Additional supplemental publications are available in electronic format to be purchased and downloaded from the College Board Store. These include a collection of 13 AP World History Teaching Units, AP Calculus free-response questions and solutions from 1969 to 1997, and the *Physics Lab Guide.*

Announcements of new electronic publications can be found on the AP Course Home Pages on AP Central (apcentral.collegeboard.com/coursehomepages).
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