



# AP<sup>®</sup> Environmental Science Daily Lesson Plans (samples)

This full-year curriculum includes:

- 142 sequential lesson plans covering the entire College Board curriculum including laboratory skills and test preparation
- A pacing calendar, a materials list, student handouts and grading rubrics
- 100% hands-on learning so the teacher can provide a student-centered classroom environment with no lecture
- Lab experiments, games, model building, debates, projects and other activities designed to promote critical thinking

Please visit our website at [www.CatalystLearningCurricula.com](http://www.CatalystLearningCurricula.com) to download additional sample lesson plans or to place an order.

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# **AP<sup>®</sup> Environmental Science Daily Lesson Plans Curriculum**

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**AP® Environmental Science Daily Lesson Plans**  
**Biodiversity, Politics and Economics Unit**  
(A sample lesson plan)

**Day 1**

**I. Topic: Functional Urban Areas**

**II. Warm-up: 5 minutes**

Prior to class, write the following on the board: Why would you prefer to live in the city instead of the country? Why would you prefer to live in the country instead of in a city?

**III. Activity One: Lego® City Planning 45 minutes**

Objectives:

- a) The learner will (TLW) manipulate the elements of a city to find the most functional and sustainable arrangement.
- b) TLW assess the pros and cons of city living while trying to minimize the negative aspects.

Materials:

One box of Lego® Creator contains enough pieces to supply eight lab groups with the following supplies:

4 pieces of yarn cut in lengths that are 24cm long

4 pieces of 2 x 4 to represent industrial facilities

2 pieces of 2 x 3 to represent transportation facilities

1 piece of 1 x 6 to represent a medical facility

17 pieces of 2 x2 to represent businesses and city buildings (police and fire departments, libraries, schools, shops, restaurants)

2 pieces of 1 x 4 to represent water supply and sewage

46 pieces of 1 x 2 to represent houses or apartments

1 32 x 32 grid upon which to place pieces

Place each set of pieces in eight plastic zipper bags and set each on a single grid sheet to be picked up when the students are ready to begin. One student handout of “Designing Sustainable Urban Areas” that follows this lesson plan,

Procedure:

1. Give each student the handout, “Designing Sustainable Urban Areas” (following this lesson plan), and ask them to read over the activities.

2. Ask that one person from each lab group pick up a grid and bag of supplies. Tell the class to begin working on Activity A and tell them they'll have five minutes to complete it.
3. After the groups have arranged their pieces, allow them to each bring up or hold up their grid to let their classmates see the layout. Ask the students the questions on the handout and allow them to discuss any issues that arise.
4. Ask the lab groups to spend the next five minutes completing Activity B.
5. After the groups have arranged their pieces, again allow them to each bring up or hold up their grid to let their classmates see the layout. Ask the students the questions on the handout and allow them to discuss any issues that arise.
6. Ask the lab groups to spend the next 15 minutes completing Activity C.
7. After the groups have arranged their pieces, allow them to each bring up or hold up their grid to let their classmates see the layout. Ask the students the questions on the handout and allow them to discuss any issues that arise.
8. Use the planning questions from Activity C to ascertain if the students have developed some conclusions about the issues concerning urban areas.
9. Allow time for the students to organize themselves as lab groups to complete Activity D. Remind them that they must complete this assignment so that they are ready to share their research at the beginning of the next class.

**HW:** Ask the students to finish Activity D from today's handout at home tonight. Tell them to be ready to share their findings at the beginning of the class period tomorrow.

**HW:** Tell the students that they must watch the video for this week, *The Power of Community*, for an activity in class tomorrow.

## Designing Sustainable Urban Areas

- Materials:**
- 4 pieces of yarn cut in lengths that are 24cm long
  - 4 pieces of 2 x 4 to represent industrial facilities
  - 2 pieces of 2 x 3 to represent transportation facilities
  - 1 piece of 1 x 6 to represent a medical facility
  - 17 pieces of 2 x 2 to represent businesses and city buildings (police and fire departments, libraries, schools, shops, restaurants)
  - 2 pieces of 1 x 4 to represent water supply and sewage
  - 46 pieces of 1 x 2 to represent houses or apartments
  - 1 32 x 32 grid upon which to place pieces

### Activity A – Maximizing Personal Space

Using all the Lego® pieces you have been given and the grid that represents your total land space, take about 5 minutes to design an urban area that maximizes the amount of personal/private space for each citizen.

#### Reflection Questions:

1. Describe the city that you have designed:
  
  
  
  
  
  
  
  
  
  
2. Quantify the amount of open/green space in the city you have designed: There are 1024 ( $32 \times 32 = 1024$ ) bumps on the empty grid. How many bumps have been left for open/green space in the city you have created?  
\_\_\_\_\_ bumps
  
3. Describe the most important things that are gained from maximizing personal living space that is privately owned and utilized:

### Activity B – Maximizing Public Space

Using all the Lego® pieces you have been given and the grid that represents your total land space, take about 5 minutes to design an urban area that maximizes the amount of public space that is available for all citizens' use.

#### Reflection Questions:

1. Describe the city that you have designed:

2. Quantify the amount of open/green space on your grid: \_\_\_\_\_bumps
3. Describe the effect of open/green space on each of the topics below:
  - a. Human quality of life:
  - b. Urban and suburban animals:
  - c. Weather and climate:
  - d. Noise pollution:
  - e. Air quality:
  - f. Water quality:

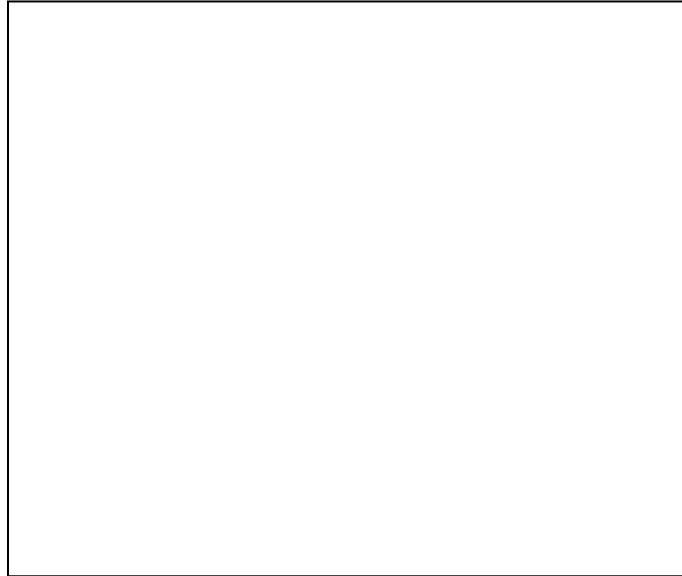
### **Activity C – Designing a Sustainable City**

Using all the Lego® pieces you have been given and the grid that represents your total land space, take about 15 minutes to design an urban area that maximizes the positive aspects of city life and minimizes the negative aspects of city life. Use the following questions to help plan your city before you present your final idea:

1. Which buildings need to be nearest to each other to minimize transportation and congestion?
2. Which buildings need to be placed apart from others due to sight, smell, noise or toxicity? Which buildings need to be near others despite their negative attributes?
3. Which buildings should be buffered by open/green areas? How can adding green spaces be used to reduce urban sprawl?
4. How can urban agriculture reduce the negative attributes of a city?
5. How do you design cities so that the people who live there have a sense of community, support and knowledge of one another?
6. How can the design of a city reduce poverty and crime?
7. What configuration of transportation veins would be most useful?
8. How do you design communities to minimize the need for duplicate resources? Are there ways to reduce waste or concentrated pollutants?
9. If nothing could be imported into a city (food/resources) or exported out (pollutants/waste), how would you alter an urban layout during planning? Remember that autonomy on an unlimited time scale is what makes a city “sustainable.”

Reflection Questions:

1. Sketch the city you designed in the grid below, labeling the buildings for clarity.



2. What are the strengths of this city layout?
3. What are the weaknesses of this city layout?
4. Consider the urban areas created by the other lab groups. Did everyone emphasize the same strengths and weaknesses? Were some aspects of city life given greater priority?
5. In your ideal urban area, what form of mass transportation would be most prominent? Explain how this form of transportation fits into your city design.

**Activity D – Modern Model Cities**

In some cities, efforts have been made to improve the quality of life for residents—certain practices have been implemented through government programs, the city layout has been redesigned and/or public works such as schools, parks or mass transportation have been enhanced. Below is a list of several cities that have made strides in one area or another. Have each person in your lab group choose a different city from the list and research that particular city's improvement projects. Have each lab member share their findings with the group. Make note of the long term effects that each of these changes will have next to the name of the city below:

1. Davis, CA, USA –
2. Curitiba, Brazil –
3. Land Conservation and Development Commission in Oregon (Urban and Rural Issues) –
4. Tapiola, Finland –
5. Chattanooga, TN –



# Designing Sustainable Urban Areas

*Teacher's Version*

## Activity A – Maximizing Personal Space

### Reflection Questions:

1. Describe the city that you have designed:  
*(Answers will vary, but the students should have their housing pieces spaced wide apart for maximum private land space.)*
2. Quantify the amount of open/green space in the city you have designed: There are  $32 \times 32 = 1024$  bumps on the empty grid, how many bumps are left open for green space in the city you have created?  
*Somewhere around 800 bumps.*
3. Describe the most important things that are gained from maximizing personal living space that is privately owned and utilized:  
*Aesthetics, relief from crowding, less tension, possibly less crime.*

## Activity B – Maximizing Public Space

### Reflection Questions:

1. Describe the city that you have designed:  
*(Answers will vary, but all the pieces should be stacked and take up a small amount of board space.)*
2. Quantify the amount of open/green space on your grid: *Around 1000 bumps.*
3. Describe the effect of public green space on each of the following:
  - a. Human quality of life: *aesthetic value, feeling of more rural placement, people spend more time outdoors in communal areas, areas are available for teaching and exploring*
  - b. Urban and suburban animals: *there are passageways through urban areas, as well as nesting, foraging and mating areas*
  - c. Weather and climate: *cooler days, more shade and less heat-retaining concrete/asphalt, trees provide wind breaks, less albedo*
  - d. Noise pollution: *vegetation absorbs noise and reduces the conduction of noise along traffic areas, reduces aggression and crime*
  - e. Air quality: *vegetation absorbs toxic air pollutants and breaks down chemicals*
  - f. Water quality: *green areas absorb precipitation instead of creating run-off so water does not pick up toxins from asphalt and concrete and run into the local surface waters, and there is reduced flooding*

## Activity C – Designing a Sustainable City

The following italicized responses are examples of points of discussion:

1. Which buildings need to be nearest to each other to minimize transportation and congestion? *Houses should be near workplaces and schools, industries should be near transport centers and businesses, etc.*
2. Which buildings need to be placed apart from others due to sight, smell, noise or toxicity? Which buildings need to be near others despite their negative attributes? *Sewage and industry away from houses, but houses need more piping to be further from sewage, etc.*
3. Which buildings should be buffered by open/green areas? How can adding green spaces be used to reduce urban sprawl? *If noisy, smelly or unsightly buildings are buffered by vegetation, they can be placed nearer to other buildings that necessitate their proximity.*
4. How can urban agriculture reduce the negative attributes of a city? *Less materials need to be imported, less transportation is used, vegetation can act as buffers, etc.*
5. How do you design cities so that the people who live there have a sense of community, support and knowledge of one another? *Create common spaces that are pleasant gathering locations—plazas, open market areas; clean/reliable public transportation that is used by all people; create smaller sub-cities within cities so that residents often see familiar faces, etc.*
6. How can the design of a city reduce poverty and crime? *Thoughtful design can result in cities that are more community-oriented, where crowding is limited, housing is affordable, the economy supports jobs for all skills levels, a strong education system exists, as well as social and economic equality among residents, etc.*
7. What configuration of transportation veins would be most useful? *To and from housing/work/school; to import and export centers, etc.*
8. How do you design communities to minimize the need for duplicate resources? Are there ways to reduce waste or concentrated pollutants? *Use cooperatives for resources that are not used 24/7, such as dump trucks, churches or office space, so that they can be shared by another business/person when not in use; mass transportation; institute resource exchange webs, etc.*
9. If nothing could be imported into a city (food/resources) or exported out (pollutants/waste), how would you alter an urban layout during planning? Remember that autonomy on an unlimited time scale is what makes a city “sustainable.” *The design would allow room for agriculture, wastes would need to be reusable/recyclable, etc.*

### Reflection Questions:

- 1-5. *(Answers will vary.)*

## Activity D – Modern Model Cities

In some cities, efforts have been made to improve the quality of life for residents—certain practices have been implemented through government programs, the city layout has been redesigned and/or public works such as schools, parks or mass transportation

have been enhanced. Below is a list of several cities that have made strides in one area or another. Have each person in your lab group choose a different city from the list and research that particular city's improvement projects. Have each lab member share their findings with the group. Make note of the long term effects that each of these changes will have next to the name of the city below:

1. Davis, CA, USA – *City restrictions on cars will encourage bicycle use and the continued development of non-petroleum transportation and promote residents' physical fitness; constraints on building and sprawl will serve to protect local farmland; green areas will help maintain the climate of the region; use of solar energy will enable the city to be more autonomous and have sustainable electricity production without needing to import coal or oil from other regions.*
2. Curitiba, Brazil – *Strict regulations on tree planting and cutting will help lower temperatures, clean air of pollutants and keep noise pollution down; no-car zones and bike paths will promote residents' physical fitness and keep air and surfaces free of pollutants; innovative ideas such as grazing sheep within city limits as a means of grass maintenance in green areas encourages waste-resource webbing and will help keep the economy flowing; high density housing allows more people with less habitat destruction and growth outward; placement of shops in residential facilities will keep transportation demands low; placement of clean industries near town allows for easy walking commute, a strong economy and lower crime; systems to help the poor improve their quality of life such as the education buses, child care facilities, healthcare and the food-for-trash exchange system will serve to reduce crime and increase the quality of life for all citizens.*
3. Land Conservation and Development Commission in Oregon (Urban and Rural Issues) – *The changes implemented to limit urban sprawl will ensure the future availability of land for agricultural use; the use of zoning, businesses mixed with housing, elimination of the expressway and a limit to parking spaces, mass transportation and constraints placed on cars will all help reduce the demand for fossil fuels and limit the dependence on imported petroleum products.*
4. Tapiola, Finland – *A community-based design places mixed income housing, commercial shops and open spaces in a centralized area to help reduce transportation demands, high temperatures and crime. Vegetation has been strategically used to reduce noise, air and visual pollution while keeping industries close enough to allow for a walking commute.*
5. Chattanooga, TN – *Chattanooga's turnaround—from being a dismally polluted city to one in which residents are enjoying dramatic environmental and economic improvements—will likely remain a source of pride and encourage the citizens to keep facing the challenges before them. The zero-emissions, zero-waste industrial park that has been proposed to renovate the South Chattanooga area is likely to be successful, given that the city has already identified a method for gaining support and achieving goals in its completion of other projects. Chattanooga's success will likely inspire other cities to tackle similar improvement projects.*

# AP<sup>®</sup> Environmental Science Daily Lesson Plans Resources and Energy Unit

(A Sample Lesson Plan)

## Day 17

I. Topic: **Solar Energy**

II. Warm-up: **5 minutes**

Prior to class, write the following on the board: "Using your hand, indicate the path that the sun would take across the sky from sunrise to sunset. Now create a labeled diagram of the path of the sun."

III. Activity One: **Solar Energy Principles** **20 minutes**

### Objectives:

- The learner will (TLW) predict the apparent path of the sun across the sky.
- TLW track the apparent path of the sun across the sky.
- TLW recognize the changes that occur in the sun's apparent height with the change of seasons.

### Materials:

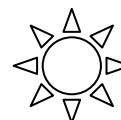
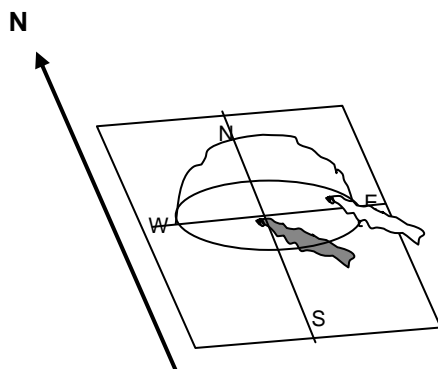
For each student: one overhead transparency marker; one plastic disposable container in the shape of a bowl; one blank sheet of copy paper; and one compass (if this is not possible, then one compass for yourself—see step two, below). For the class: one compass (if you do not have compasses for each individual); one piece of chalk; a stapler; and a meter stick.

*Special note: This procedure was written for teachers living in North America. If you are teaching in another hemisphere, you will need to make the necessary adjustments.*

### Procedure:

- Prior to class, make a sun tracker for each student in your class (or, if you have longer class periods, have the students make their own during class): Fold a blank sheet of paper in half, each direction. Using a thin-tip marker, trace both folds so the lines cross at right angles in the center of the page (see step 7 for a diagram of a sun tracker). Staple the plastic bowl container upside-down onto the piece of paper **such that the bowl is centered directly over the place where the two lines cross**. Label the top of the paper "North," the bottom of the paper "South," the right side of the paper "East" and the left side "West."
- Near your classroom, find a place outside where you are able to see the east and west horizons fairly well. Use a compass to find true north and draw a one-meter line alongside the compass on the sidewalk using a piece of chalk. Place an arrow and the letter "N" at the top of this line to give the students a place to orient their sun trackers. About four students can line their sun trackers up to this line at one time. Repeat this process about a meter away for the next four students to use until there are enough north lines for all the students in your class.

3. Give each student a sun tracker and an overhead transparency pen. Ask the students to predict the path of the sun on their sun trackers by drawing a line across the bowl showing the sun's path for the winter and summer solstices and the spring and autumn equinoxes. Ask them to label each path.
4. Discuss the concept of the equinoxes and the solstices, including mention of the relative position of the sun. You may need to review the positions of the earth and sun in this discussion, to remind the students how the seasons change due to the tilt of the earth (students often have misconceptions of how the seasons occur, based on misinformation they received while growing up). Here are a few questions you can use to test their understanding and identify misconceptions:
  - a. Does the sun ever appear directly overhead where you live? *(If you live north of the Tropic of Cancer (i.e., anywhere but Florida or southern Texas), the sun will never appear to be directly overhead—it will always appear to travel across the southern part of the sky, and it will come to its highest point in the sky at the summer solstice.)*
  - b. If, on December 21<sup>st</sup> or 22<sup>nd</sup>, the sun appeared to travel directly from the east to the west and was directly overhead at noon, where would you be? *(Anywhere along the Tropic of Capricorn—for instance, in South Africa, southern Australia or central Chile.)*
  - c. Using your finger, draw a path in the sky tracing the correct direction for the apparent journey of the sun on June 21<sup>st</sup>, if you lived on the equator. *(The sun would appear to rise just north of due east, travel across the northern sky, and set just north of due west.)*
5. Ask the students to trade transparency pens, so that each has a different color pen with which to track the path of the sun on their sun tracker.
6. To begin collecting data on the sun's apparent path, all the students need to orient their sun trackers so that the "N" at the top of their page is pointing to north. They can do this by aligning the edge of the paper on the ground against one of the north lines that you drew before class or by laying their paper on the ground against a compass that is aligned to north.
7. Once their sun tracker is correctly lined up with north, the shadow of the tip of a transparency pen can be lined up with the crosshairs in the center of the piece of paper. Keeping the shadow of the pen tip on the crosshairs, they should then lower the pen until it is touching the plastic bowl and make a small dot. Have them label the dot with the exact time and date. This dot represents what the sun's position in the sky would be if the student were standing on the crosshairs under the plastic bowl.



The shadow of the pen-tip must fall where the lines cross under the bowl

8. Tell the students they will need to come back to this exact place with their sun tracker at least three more times today to take data points at a minimum of 30 minutes apart. Tell the students they should also take at least one measurement tomorrow morning before class.
9. Return to the class to introduce the topic of solar energy, or hold class outside, if possible, to use the sun's energy as a demonstration.

#### IV. Activity Two: Solar Energy Applications

25 minutes

##### Objectives:

- a) The learner will (TLW) discover how solar energy can best be captured and used.
- b) TLW understand the difference between passive and active solar energy systems.

##### Materials:

For the class: a slide show of images as described in step one below; a computer, or a screen and projector; several passive and active solar energy collectors borrowed from a solar energy supplier or installer (such as an evacuated tube solar collector, a photovoltaic cell, super-insulated windows, solar tube lights, etc.).

##### Procedure:

1. You may want to have a home energy company come in to talk to your students about active and passive solar energy applications. They will be able to bring in collectors for hot water and for electricity and show pictures of how the systems are used in residences and businesses. If you do not have a guest speaker, you can create a slide show to give your students a visual of how solar energy is applied in passive and active forms. Following are some images you will want to collect for your slide show. Examples of passive solar applications: south-facing windows with blinds; a diagram of triple-glazed super-insulated glass; greenhouses; greenhouses attached to houses; black water barrels or stone flooring to act as a thermal mass that heats during the day and radiates during the night; solar tube lights; skylights; roof eaves long enough to block summer sun and short enough to maximize winter sun; a solar oven, solar collecting pool covers, etc. Examples of active solar applications: a diagram of an enveloped house; a flat-panel solar hot water heater installed on a house or next to a house; an evacuated tube solar collector and an assembly of tubes set up to heat water for a house; a solar pond and diagram of how it works; a diagram of a photovoltaic (PV) cell; a PV panel; and a PV array mounted on a building or free-standing; a large-scale solar energy generating station, etc.
2. Relate what the students did in Activity One to the concepts of solar energy collection by asking questions to generate a discussion:
  - a. How does the position of the sun affect how and when a person can use solar energy? (*The amount of energy available differs according to the device's location on earth, the season, the angle of the device and the direction it is facing.*)
  - b. What parts of the world have the maximum amount of solar energy available for collection? (*Places nearer to the equator and places with clear weather and little vegetation to block collectors.*)

- c. What can you do to collect solar energy in places that do not have the maximum solar gain? (*Collectors can be angled toward the sun or can be moved to track the sun's movement.*)
  - d. What is the difference between passive solar and active solar? (*Active solar requires a motor, pump or some mechanical device.*)
  - e. How can we benefit from solar energy? (*We can obtain light, heat, ventilation, electricity, hot water, cooking fuel, etc.*)
3. Introduce some passive ways to obtain heat, light or ventilation using solar energy. Use the slide show of images you have collected to explain the concepts of passive solar energy use. Explain how solar gain can be regulated with compartmentalization, fans and other techniques. For instance, a greenhouse with sliding doors can be attached to the daytime living area of a house to let in light and heat the space for use in the winter. If the greenhouse is able to absorb heat (perhaps the floor is made of slate, or there are water barrels in this area or a rock wall), it can radiate the heat into the house all night, when the sun is down. If the greenhouse gets too hot during the day or too cold during the night, the room can be closed off.
  4. Be sure to remind the students that often, during the summer, heat and light are unwanted in the amount available and so there are heat- and light-reducing designs as well (roof eaves; smaller south-facing windows; plants positioned to grow over windows/greenhouses/patios/roofs; awnings, shutters and louvered windows; mature deciduous trees on the south side of a house block out sun with summer foliage and allow light and heat during the winter when they are bare, etc.).
  5. Introduce how active solar systems work, starting with the least complicated concepts (solar hot water heating; enveloped house with a basement and fans to circulate air; solar ponds; etc.).
  6. Explain how a photovoltaic cell is able to convert solar radiation into electricity. Use images to show the students what PV panels and arrays look like (they may not realize that they have seen these used to light up billboards or power emergency phones, etc.).
  7. Remind the students about their EcoHome project. Ask them if they will need to maximize or minimize light and heat in their particular location. Ask the students which systems and ideas might be useful for their particular project.
  8. Tell the students they will work in pairs (or lab groups) tomorrow to create a solar oven based on what they have learned about the basic principles of passive solar energy collection. The students will be allowed to build their own solar oven based on an original design. In order to determine which oven has the best design, a one-liter bottle of water will be placed in each and water temperatures will be compared after all of the ovens have been in the sun for the same amount of time. Therefore, each oven design must feature an interior space large enough to accommodate a one-liter water bottle. Ask the students to begin working on their solar oven design in pairs or lab groups.

**HW:** Ask the students to bring a completed drawing of their solar oven for tomorrow's class.

**AP® Environmental Science Daily Lesson Plans**  
**Toxicity, Pesticides and Agriculture Unit**  
(A sample lesson plan)

**Day 9**

**I. Topic: Composting**

**II. Warm-up:** **5 minutes** Prior to class, write the following on the board: Gather with all classmates who have written a lab experiment using the variable you chose (either aeration, moisture, pH, temperature or agitation) and share your experiment ideas. As a group, create the ideal lab procedure (based on one person's idea or a compilation of several people's ideas).

**III. Activity One: Encouraging Composting** **45 minutes**

Objectives:

- a) The learner will (TLW) work with a lab group to refine an idea for a good scientific experiment.
- b) TLW carry out the experiment with their group and analyze the results.

Materials:

For each lab group: six disposable plastic food storage containers with lids; three sheets of newspaper; one banana peel; one large jar of applesauce; one ruler. Some lab groups might also need: water; pH test strips; vinegar; baking soda; straws; stirring rods; an incubator; a refrigerator.

Procedure:

1. Give each lab group the first set of supplies listed above and ask each group to prepare six identical containers of garbage in the following manner:
  - a. Cut the banana peel into six approximately equal strips and place one strip in each container.
  - b. Tear half a sheet of newspaper into strips that are about 3cm in width and place the same number of strips into each container, layering the strips with the applesauce and a 1/2 cup of water.
  - c. Stir until all the components are mixed.
2. Ask each group to use the ideal lab experiment designed in the warm-up to test the effects of one variable (that they selected). They should begin following their lab procedure. For instance, if a lab group is testing moisture, they might add different amounts of water to each container and note the changes in decomposition over time; if a group is aerating the garbage, they may place straws into the containers at fixed points and add a set number of breaths at set intervals, etc. Realize that some experiments may need modifications in the procedure as decomposition progresses (for example, the lids might need to be "burped" or put back on the containers; aeration straws may need to be adjusted,



- etc.). Special note: If the procedure for the lab group testing pH compromises the integrity of the plastic container, glass containers may need to be used for the experiment.
3. After all groups have finished performing their experimental set-up, discuss the choices they've made concerning the following topics:
    - a. How will they measure the differences in the rates of decomposition? Can they think of a quantitative way to measure the changes that will take place?
    - b. How will they eliminate other variables, such as agitation and temperature?
    - c. What is their hypothesis of the effect this variable will have on the rate of decomposition?
  4. This is an on-going experiment that may take several months. Please mark dates on the calendar that represent regular intervals at which you and the class can discuss the data they're collecting in their experiments. You may also want to assign a deadline for a lab report write-up or presentation.

**HW:** Remind the students to prepare for their Ch. 7 reading quiz in *When Smoke Ran Like Water*.

**HW:** Ask the students to write the methods section of their composting lab.

**AP® Environmental Science Daily Lesson Plans**  
**Biodiversity, Politics and Economics Unit**  
(A sample lesson plan)

**Day 12**

**I. Topic: Influences on Government Lawmakers**

**II. Warm-up:** **5 minutes** Prior to class, write the following on the board: How does a member of Congress make decisions about bills that come to the floor? *(A congressperson is elected to represent the people from their state or region, so he or she will often be interested in voting according to their constituents' interests. However, there will also be other powerful persons/groups around the congressperson, attempting to persuade him or her to vote according to their interests.)*

**III. Activity One: Tabulating the Votes: Subsidies** **35 minutes**

Objectives:

- a) The learner will (TLW) represent different lobbyists in a particular case example to demonstrate how these players interact to influence the decision-making of congresspersons.
- b) TLW witness the interactions of students role-playing the interests of different groups and decide how they would vote under these influences if they were a member of Congress.

Materials:

For each student: a copy of the "Voting Card" handout; and enough "Hello, my name is..." stickers to allow two per student. Also, the students will need the props they brought for their role-play.

Procedure:

1. Give each student a copy of the "Voting Card" handout and two blank "Hello, my name is..." stickers.
2. Ask the students to each write their two identities on the stickers: the first sticker will go on the right side of their shirt and will list the identity of the role they will play as a lobbyist. The second sticker will go on the left side of their shirt and will identify which state they represent in Congress. Ask the students to choose a state that they know fairly well. Ask the students who have lived out of state or have knowledge of a state other than the one they are currently living in to use that state so there is more diversity in the class. Or, appoint a state to each student and spend a few minutes discussing with them the issues that are important to their state (allowing them to use the Internet for research, if necessary):
  - a. What are the primary industries in the state you represent?
  - b. What issues have had a great impact on your state in the past 50 years?

- c. What are the chief concerns of each of the major parties (Democratic and Republican) in your state?
3. Tell the students that each of them is a congressperson who represents the voters in their state. Tell them that they will be asked to listen to the hearings on several bills on financial legislation and then they will be asked to vote for or against each bill.
4. Each subsidy group will come before Congress and try to persuade the members of Congress to vote for or against the subsidy of their industry. While they are before Congress, they will be playing the role of lobbyists or special interest groups (the name on the right shoulder). When they are finished presenting their case, they will return to the audience to resume their role as a congressperson from a particular state (the name on their left shoulder).
5. Determine the amount of time (a suggested range is 1.5-3 minutes) the students will each be given to present their case and warn them that they will be cut off if they go over the limit. Ask the first lab group to present their subsidy topic. Each group member should take turns appealing to congresspersons for their vote using facts, statistics or other qualitative factors they found in their research.
6. After all members of the group have made their case before Congress, ask the congresspersons to vote to continue the subsidies or discontinue them. They should mark their intentions in the “I plan to vote to continue/discontinue...” column of the “Voting Card” handout. Remind your students that if they spend too much money, their constituents may be unhappy with their fiscal irresponsibility and the higher taxes that result, and may not re-elect them. Also, if they do not support the industries and issues that generate money in their state, their voters will not be happy with the state economy, and may choose not to re-elect them.
7. Your students/congresspersons have just finished their workday, and they will now be invited to a cocktail party (where their work will continue, albeit in a social setting).

#### **IV. Activity Two: Congressional Cocktail Party**

**10 minutes**

##### Objectives:

- a) The learner will (TLW) role-play a member of Congress and/or a lobbyist mingling at a cocktail party.
- b) TLW understand the factors that influence law-making.

##### Materials:

Cookies, plastic champagne glasses and sparkling cider for the class.  
For each student: the “Voting Card” handout they filled out in the activity above.

##### Procedure:

1. Invite your congresspersons to a cocktail party where they can socialize and lobby one another to change their votes. A student may speak from either of their identities—as a congressperson or as a lobbyist. Explain to your students that congresspersons will often trade favors (votes) on issues so that bills that are important to their constituents have the support they need to pass.

2. If a congressperson decides to change their vote, they must mark that change in a different color ink on their "Voting Card" handout and write a brief explanation of why they changed their vote.
3. While the people at the cocktail party are mingling, draw on the blackboard a voting card that resembles the one on the handout.
4. Sound a bell to indicate that voting is about to take place. (In Congress, a bell is used to notify members that voting is about to take place on the floor of the Senate or House, because often members do not attend the informational hearings that take place before a vote.)
5. Ask for a show of hands on each issue and tabulate the votes on the card that you drew on the blackboard. Congratulate the lobbyists that were able to persuade the majority of the congresspersons on their issues.

**HW:** Ask the students to research a grassroots organization or citizens' action group from their region. Tell the students they must be ready to report the issue and position of this action group in tomorrow's class.

## Voting Card

I represent the people of the state of \_\_\_\_\_.

Topic:	I plan to vote to continue/ discontinue subsidies (write "cont." or "discont." in the following boxes):	Reason for my vote:
Logging		
Water		
Oil/Gas		
Corn/biofuel		
Milk		
Mining		
Cotton		
Cattle grazing		

Brief explanation of any vote changes made:

**AP<sup>®</sup> Environmental Science Daily Lesson Plans**  
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**Day 5 - Extended Lab Day**

**I. Topic: Field Collections**

**II. Warm-up: 5 minutes**

Prior to class, write the following on the board: Prepare to go outside (bringing with you a field journal and a pen) and be ready to answer the question: Why do scientists categorize organisms?

**III. Activity One: Creating Dichotomous Keys 20 minutes**

Objectives:

- a) The learner will (TLW) create their own dichotomous key using familiar objects and descriptors.
- b) TLW discover how to categorize items in terms of their similarities and differences.

Materials:

The students will each need a field journal and pen.

Procedure:

1. Take the students out to the shade of the tree you plan to use for Activity Two, below.
2. Ask each student to place one of their two shoes in a pile in the middle of the group.
3. Tell the students that the shoes represent a group of similar organisms that can be found in your area. Tell the students that they are the scientists responsible for creating a dichotomous key to identify each species of shoe. You will probably need to discuss the definition of a dichotomous key. As with any new terms, first ask the students if there is anyone who knows what this is and can explain it to the class. Ask someone to give an example. If they are at a loss, give them a very brief description or example to see if that jogs anyone's memory, then return the work of explaining the term to one of the students, if possible.
4. Let them know that for this exercise they will be making the assumption that similar features represent homologous characteristics or features that have a similar evolutionary origin.
5. Ask the students to take a closer look at the species in the pile and start sorting them according to similarities and differences. Tell them they must start the process by creating a question that, when answered, will help sort the organisms into two different piles.
6. After they have made some significant observations and seem to be finding ways to sort out the group, ask the students to suggest one concise question that will

- clearly divide the organisms into two different piles with at least two shoe types in each pile. As students share their ideas, point out that this question must address a feature that is shared by all the organisms, so that each species can be easily sorted into one pile or the other with a simple “yes” or “no” to the question. For example, “Does the organism close over the toes or leave the toes open to the elements?” Point out that a question that is not specific could cause a person to make the wrong turn at an early point in the identification process. For example, “Is the organism used for recreation or business wear?” is not a good dichotomous key question because it is subject to opinion. Ask the class to choose the best question from the ones suggested.
7. Ask the students to write this question down in their notebooks and number it “1.” On the line after the question, tell the students to write the phrase, “If yes, go to question 2” and “If no, go to question \_\_\_\_.” Tell the students that they will fill in the question number in a few minutes.
  8. Ask a student to go ahead and sort the organisms into the two piles based on question 1. This person should check with the class as they sort each organism.
  9. Now ask the students to suggest a question that can be used to subdivide one of the two groups. When they decide on the best question, they should record it in their notebooks with the phrases, “If yes, go to question 3” and “If no, go to question \_\_\_\_.” Have them continue this process until they have created questions to subdivide the group to the point that only one species is a logical answer to the final question.
  10. When the students have gotten to the end of a line of questions and have singled out a particular species of shoe, they should give that shoe a genus and species name typical of the Linnaean system of nomenclature, (but with a silly spin of course, because after all, they are classifying shoes!). The genus name is capitalized, the species name is lower case and both are either italicized or underlined. The genus name should be shared with other shoes of the same lineage (the students can decide where the genera are divided), and the species name should reflect a specific, identifying ecological, morphological or behavioral feature, or the area in which this species is typically found.
  11. After the activity, lead a short Socratic discussion to draw out the main points of the exercise:
    - a. Can you now explain what a dichotomous key is?
    - b. What is the purpose of this type of key?
    - c. Is a dichotomous key representative of the common evolutionary origin of the species being classified or simply a representation of the common features of those species?

#### IV. Activity Two: Using Dichotomous Keys

**30 minutes**

##### Objectives:

- a) The learner will (TLW) use a dichotomous key to identify tree species.
- b) TLW discover how to decipher unfamiliar vocabulary and terms used in scientific field guides.

##### Materials:

For each student: one field guide with dichotomous keys to identify North American trees (do not get color picture identification guides—they do not use dichotomous keys); a field journal and pen. For the class:

dichotomous field guides for as many other groups as possible—insects, fungi, birds, amphibians/reptiles, mammals, fish, rocks, seashells, etc.

Procedure:

1. Prior to class, find a tree species near the classroom that is native to North America and can be easily identified with the field guide your students will be using. It's a good idea to familiarize yourself with the guide, so that you can answer questions when the students get stuck.
2. Take the students to the tree you selected, but before you get there ask them not to reveal the name of the tree to anyone, if they know what the tree is.
3. Give the students the field guide and introduce them to the parts of the guide they will be using. Point out the location of the glossary, the keys to each of the major groups, the species descriptions, the anatomy diagrams and the plates with pictures of trees, leaves, fruit and flowers.
4. Spend some time going over the anatomy diagrams of opposite, alternate, simple and compound leaf structures as well as any other terms you know will come up immediately for this particular species.
5. With the students working in pairs, ask them to gently remove one sample that includes a leaf, a leaf node and a fruit or flower, if there are many present. You can also ask them to sit very near the tree and not remove any part of it. However, if tree collections are one of the projects your students will be doing, this would be a great time to teach them how to select an informative sample while incurring the least amount of damage.
6. Start by working the keys aloud as a class, until you feel the students are doing fine. Ask the student pairs to continue working their way through the dichotomous key until they can identify the tree down to genus and species. Circulate to help any students that get stuck.
7. After they have completed this challenge, allow the student pairs to each choose another tree. Be sure they choose native trees so that the species will be in the field guide.
8. If time allows, let the students browse through some of the other field guides so they can see how different guides are set up in roughly the same way.

**V. Activity Three: Begin a Natural History Collection                      20 minutes**

Objectives:

- a) The learner will (TLW) notice the similarities and differences in the organisms found in their region.
- b) TLW develop techniques to identify, collect and preserve organisms for study and display.

*Special note: This lesson plan instructs teachers on how to begin a natural history collection using insects, although you may choose to collect some other group of organisms, such as plants, birds, etc. The collections do not need to involve killing the organisms, but can instead be comprised of drawings (or tracings from a field guide), which would give students the opportunity to sharpen their observation skills. If your students would like to capture insects for a live collection, they will need to take into account compatibility of species and the appropriate duration for keeping insects captive. If they want to kill and mount the insects they catch, any good field guide will describe*



*the best techniques for killing, preserving and mounting insects in a display box. If your students are collecting plant samples (trees are easiest to identify), you can use an old phone book to press the fresh leaves or flowers between weighted pages and then mount them when they have dried. Perhaps some of your students will want to collect insects and others will want to collect trees (leaves, fruit and flowers), or you may require that all students collect a particular type of taxa. (To reduce the number of field guides needed, you can ask the students to work on a project in pairs or groups.)*

Materials:

For each student: a field guide for the local area, for the topics your class will be studying (insects and trees are easiest, if you are requiring that a physical collection be turned in); and one copy of the “Insect Collection Project” handout (or provide a handout pertinent to the organisms they’re studying). If possible, have an insect collection (or dried plant specimens, etc.) to show the students.

Procedure:

1. Distribute the “Insect Collection Project” (or other pertinent) handout and discuss the project with the class.
2. Show them an example of a scientific collection that is well-preserved and well-labeled.
3. Alert them to the due dates for this project, in which they’ll be collecting 10 different samples a week for a weekly grade. The final project grade will take into account the diversity of their collection, and the preservation, identification, labeling and mounting of each specimen.
4. The next activity will allow them time to brainstorm ideas for refining their sample collection techniques.
5. All lesson plans from this point on will refer to this activity as an insect collection. (If your students are collecting trees or another group of organisms, or if your students are collecting drawings of captured and released organisms, simply change the activity to suit your particular project.) There will be class time scheduled on Day 22 of this unit and on Day 5 of the Population Dynamics unit for completion of this project. (The scheduled due date for this project is Day 6 of Population Dynamics.)

**VI. Activity Four: Begin Fruit Fly Collection**

**15 minutes**

Objectives:

- a) The learner will (TLW) catch a fruit fly to begin a population study.
- b) TLW become familiar with a common scientific study organism.

Materials:

For each student: one fruit fly growth tube; 1 inch of fruit fly growth media (instant mashed potatoes with blue fungicide and water) to be put at the bottom of each student’s tube; and a foam stopper for each tube.

Procedure:

1. Give each student a fruit fly culture tube. Ask the students to each catch a fruit fly at home this weekend by placing a ripe banana beside the tube and placing the stopper into the tube when a fly enters it. It would help to pass around a fruit fly that you have already caught, so the students are able to identify the type of organism they want to catch. It might be helpful to award bonus points for each fly caught, to help insure that you have a large enough starting population.
2. When the students bring in their fruit flies, knock the flies out by refrigerating them for a few hours or using Fly Nap<sup>®</sup>. Place 3-5 flies in each tube, being sure to make at least one tube for each lab group. Keep the knocked out flies from falling into the wet potato culture by storing the tubes on their sides until the flies wake up. You can right the tubes when they are awake.
3. During the first week, you should see eggs along the walls of the tube (they look like small dried salt crystals). When this occurs, take a minute during class to pass the tubes around, so the students can note the number of eggs laid compared to the number of females in the tube. Point out the high biotic potential of this species.
4. By the beginning of the second week, the larvae will have emerged from the eggs and traveled down to live in the potato culture. You will notice their dark mouths and white bodies making trails through the culture. Again, when this occurs pass the tubes around so that your students can observe the life cycle of this species.
5. By the end of the second week, the larvae will form cysts on the walls of the tube to metamorphose into adults. Take a minute to let the students make observations and notes during this stage, discussing the egg to cyst ratio of survivorship for this species.
6. When the adults emerge from the cysts, your students can begin counting them each week at a regular interval. Make this a part of your weekly routine or a weekly homework assignment. Students should take turns performing this task with their lab group members.

**HW:** Ask the students to continue their field collections so that they have 10 organisms representing different orders (if the students are collecting insects) or families (if they are collecting plants).

**HW:** Remind the students to look at the year calendar for reading and video assignments.



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