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# Age Levels:

* 9-12 Biology I or II, Introduction to Engineering & Design, or any Engineering Technology Class

# Total Time Required:

### We completed this as an ongoing project for a semester. The Engineering students spent two days a week on the project for about 12 weeks. Biology students spent about 5 weeks on an Invertebrate Unit. The [Invertebrate Unit Notes](https://www.dropbox.com/home/TRAILS%20Website_Official/Lesson%20Plans/Bug%20RV?preview=Animal+%26+Invert+Notes.pptx) are linked here if you are interested. The actual activities needed for collaboration take about a week and a half. Students also collaborated about one day a week during Student Resource time. We feel that this project could be done with less time if consolidated.

# Prepared by:

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* June 2016

# Unit Objectives:

Students will be able to:

* Use a decision matrix to determine the best possible solution to a problem
* Design a habitat for insects
* Differentiate between different types of arthropod

# Science Standards and Standards for Technology Literacy:

Below are Biology and Engineering standards that this unit addresses.

## Biology II: The following are Student Learning Objective

* Identify 20 common arthropods in Indiana
* Differentiate between different types of arthropods
* List places you likely to find insects
* Describe why insects are ecologically important

## Biology II: **Math, Literacies, 21st Century Skills**

* 9-10.RS.1/9-10.RT.1 Cite specific textual evidence
* 9-10.RS.3/9-10.RT.3 Follow precisely a complex multistep procedure
* 9-10.RS.5/9-10.RT.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms
* 9-10.WS.2/9-10.WT.2 Write informative/explanatory texts
* 9-10.WS.6/9-10.WT.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products
* 9-10.WS.8/9-10.WT.8 Gather relevant information
* Students will be able to collaborate, communicate, be creative, & think critically

## Standards for Technology Literacy: IED State Standards

* IED-1.4Apply and adapt the design loop as a guide to solving a problem or creating a solution
* IED-6.3 Evaluate a sketch and generate a model using appropriate modeling materials
* IED-7.14 Grade design solutions that use specific elements, principles, and functions to solve problems & communicate ideas.

## Standards for Technology Literacy: IED **Math, Literacies, 21st Century Skills**

* 9-10.RS.3 Follow precisely a complex multistep procedure
* 9-10.RS.5 Analyze the structure of the relationships among content in text
* 9-10.RS.3/9-10.RT.3 Follow precisely a complex multistep procedure
* 9-10.RS.5/9-10.RT.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms
* Students will be able to collaborate, communicate, be creative, & think critically

# Recommended Instructor Preparation

* **Prior to this lesson, they must be taught the basics of 3D CAD modeling.**
* **Teachers need to be familiar with the types of arthropods present in their area and be able to differentiate between common arthropods.**
* **Teacher should have a surveying level, 300’ tape measure and google map of location of the trees.**

Lesson Plan 1: Brainstorming

# Lesson Focus:

Students from Biology II and Engineering will collaborate to develop brainstorming techniques

# Total Time Required:

* 40 min.

# Lesson Objectives:

Students will be able to:

* Understand the reason for brainstorming
* Understand various techniques of brainstorming
* Use simple sketches for brainstorming

# Equipment and Materials

|  |  |
| --- | --- |
| Tools and Materials | Quantity Needed |
| Engineering notebook | 1 / student |
| Projector to present PowerPoint or computer for students to access the PowerPoint | 1 projector / class or 1 computer / group |
| Marshmallows  | 20 / group |
| Uncooked spaghetti | 12 “sticks” / group |
| Meter stick / yard stick | 1 / group |

**Lesson Procedures:**

1. Students will copy the notes on brainstorming into their engineering notebooks (either from the projector or off Google Classroom). This includes slides 1-5 of the brainstorming PowerPoint. This is included in Student Resources below.
2. Students will complete the brainstorming activity and “spaghetti tower” build. The instructions are in slides 6-7 of the brainstorming PowerPoint. This is included in Student Resources below.

# Student Resources:

[Brainstorming PowerPoint](https://www.dropbox.com/home/TRAILS%20Website_Official/Lesson%20Plans/Bug%20RV?preview=Brainstorming+with+Tower+PowerPoint.pptx)

Lesson Plan 2: Bug RVs Introduction & Brainstorming

# Lesson Focus:

Students will be introduced to the Bug RV project and begin brainstorming designs. This will be done with Biology and Engineering student groups working in collaboration.

# Total Time Required:

* 40 min.

# Lesson Objectives:

Students will be able to:

* Students will become familiar with the Bug RV project
* Students will produce at least 5 unique ideas for Bug RVs in each collaborative group

# Equipment and Materials

|  |  |
| --- | --- |
| Tools and Materials | Quantity Needed |
| Engineering notebook | 1 / student |
| Bug RV Design Brief | 1 / student |
| Large paper (24” x 24” or larger) | 1 / group |

**Lesson Procedures:**

1. Students will be given the design brief for the Bug RVs. They will go over the criteria and constraints. This is available in the Student Resources on the next page.
2. Student will review with teachers what they previously learned about brainstorming.
3. Each student working ALONE produces 3 unique ideas for the Bug RVs. These will be sketched in their engineering notebook
4. Students will join with their collaborative groups and share their ideas. These may need to be sketched on the large paper.
5. As a group, they agree on at least 5 possible ideas. These should be sketched into their engineering notebook. In future group meetings, groups will decide which is best based on a decision matrix.

*Note:* In future group meetings, groups will decide which is best based on a decision matrix.

# Student Resources:

[Bug RVs Design Brief](https://www.dropbox.com/home/TRAILS%20Website_Official/Lesson%20Plans/Bug%20RV?preview=Bu+RV+Design+Brief.docx)

Lesson Plan 3 : Decision Matrix

# Lesson Focus:

Students will learn to use a decision matrix to determine which designs fit the constraints the best. Students use this information to pick the best design for a Bug RV.

# Total Time Required:

* 30 min

# Lesson Objectives:

Students will be able to:

* Use a decision matrix
* Choose the best design in their group for their Bug RV

# Equipment and Materials

|  |  |
| --- | --- |
| Tools and Materials | Quantity Needed |
| Example Decision Matrix | 1 / student |
| Bug RV Decision Matrix | 1 / student |
| Engineering Notebook | 1 / student |

**Lesson Procedures:**

1. Students will go over the example decision matrix with the teacher.
2. Students will practice ranking a Bug RV sketch on the example decision matrix.
3. Students will refer to the 5 ideas their collaborative groups developed at the last meeting. The best 3 ideas should be run through the decision matrix to determine which is the best idea. This is the design that will be draw in the 3D CAD software program and 3D printed.

# Student Resources:

[Bug RV Decision Matrix](https://www.dropbox.com/home/TRAILS%20Website_Official/Lesson%20Plans/Bug%20RV?preview=Bug+RV+Decision+Matrix.pptx)

Lesson Plan 4: Arthropod PowerPoint

# Lesson Focus:

Biology II students research different types of arthropods. They use their research to develop a PowerPoint that they will teach to their collaborative group of Engineering students.

# Total Time Required:

* 3 class periods of about 40 minutes

# Lesson Objectives:

Students will be able to:

* Research and gather relevant information
* Cite information using MLA
* Organize information into clear, concise PowerPoint
* Explain/teach information on arthropods

# Equipment and Materials

|  |  |
| --- | --- |
| Tools and Materials | Quantity Needed |
| Computer with internet access | 1 / student |
| Engineering notebook | 1 / student |

**Lesson Procedures:**

1. Students are given the Arthropod PowerPoint Assignment. This is included in the Student Resource section on the next page.
2. Students are given 3 days to research and build a PowerPoint.
3. Students will present/teach the PowerPoint information at the next collaborative meeting with Engineering students in SRT.

# Student Resources:

[Arthropod PowerPoint Assignment](https://www.dropbox.com/home/TRAILS%20Website_Official/Lesson%20Plans/Bug%20RV?preview=SRT+Arthropod+PowerPoint+Instructions.pptx)

Lesson Plan 5: Collecting Aquatic Macroinvertebrates

# Lesson Focus:

Students will be collecting aquatic macroinvertebrates from our school pond and comparing it to a sampling taken from the Elkhart River by the teacher. Students will be doing basic identification and determining a basic level of water quality for the two bodies of water.

# Total Time Required:

* 90 minutes This can be split up into two class periods. They can collect from the pond on one day & compare on another.

# Lesson Objectives:

Students will be able to:

* Collect aquatic macroinvertebrates
* Identify common invertebrates
* Evaluate basic water quality

# Equipment and Materials

|  |  |
| --- | --- |
| Tools and Materials | Quantity Needed |
| Bottomless bucket | 1 / class |
| Small fish net | 1 / class |
| Small plastic container | 1 / group of 3-4 students |
| Ice cube trays | 1 / group of 3-4 students |
| Plastic spoons | 1 / student |
|  |  |
| OPTIONAL Materials: |  |
| Screen or sein  | 1 / class |
| Clear plastic makeup cases or glass vials (see notes below) | 1 / every invertebrate collected |
| Hand sanitizer (needs high alcohol content) | 1 liter / class |

## Special Notes on Materials:

Insects can be collected to identify later by putting them in vials of alcohol or hand sanitizer. The hand sanitizer works well because it does not spill. I prefer to collect them in clear plastic makeup cases. These work well because of the flat lids as opposed to the cylindrical vials. Here is a link from amazon.com with the type of [cases](https://www.amazon.com/Bekith-Clear-Plastic-Cosmetic-Containers/dp/B06XDT3RT8/ref%3Dsr_1_5?crid=3L138UMLMR4VR&keywords=makeup+plastic+containers+with+lids&qid=1559662049&s=gateway&sprefix=makeup+plastic%2Caps%2C167&sr=8-5) I am talking about. They come in many sizes.

**Lesson Procedures:**

1. Take students to a body of water OR bring samples to the students to observe.
2. Samples of macroinvertebrates can be easily done with a bottomless bucket and an aquarium fish net. Set the bucket firmly on the bottom of the pond or river bank with the top above the water. Stir thoroughly with the net (in the water column and the bottom. The bucket keeps the organisms from escaping. Scoop through the water column & across the bottom several times. Dump the net’s contents in small plastic containers with a little water in them. Details on this method can be found in this website in the D-Bait lesson.
3. Students should let the water settle in their plastic containers. They can then scoop out anything that wiggles with their spoons. These are sorted into ice cube trays by type.
4. The organisms can be collected for later identification by placing the organisms in plastic cases or glass vials with alcohol or hand sanitizer.  Details on this method can be found in this website in the D-Bait lesson. Students are also encouraged to take videos of how the arthropods move to show Engineering students in collaborative meetings.  Preserved specimens can also be brought to collaborative meetings.
5. Students fill out the Hoosier River Watch Data Sheets.  These are included in the Aquatic Macroinvertebrate Activity in the Student Resource section on the next page.

# Student Resources:

[Aquatic Macroinvertebrate Activity](https://www.dropbox.com/home/TRAILS%20Website_Official/Lesson%20Plans/Bug%20RV?preview=Aquatic+Macroinvertebrates.docx)

# Additional Supplemental Activities:

[Build a Bodacious Bug Activity](https://www.dropbox.com/home/TRAILS%20Website_Official/Lesson%20Plans/Bug%20RV?preview=Build+a+Bodacious+Bug.docx)

[Metamorphosis Online Activity](https://www.dropbox.com/home/TRAILS%20Website_Official/Lesson%20Plans/Bug%20RV?preview=Build+a+Bodacious+Bug.docx)

Lesson Plan 6: Terrestrial Arthropod Collection

# Lesson Focus:

Students collect and identify terrestrial arthropods.

# Total Time Required:

* 2-3 class periods. One 45 minute class period to collect and then 1-2 class periods to identify organisms.

# Lesson Objectives:

Students will be able to:

* Catch and collect terrestrial arthropods
* Identify common arthropods

# Equipment and Materials

|  |  |
| --- | --- |
| Tools and Materials | Quantity Needed |
| Butterfly nets | 1 / group |
| Clear plastic card case (see notes below) | 2-3 / group |
| Clear plastic makeup cases or glass vials (see notes below) | 1 / every invertebrate collected |
| Hand sanitizer (needs high alcohol content) | 1 liter / class |
| Insect and Arachnid identification books such Peterson’s or Golden Guide | 2 types per group |
| Computer with internet access | 1 / student or group |
| Engineering Notebook | 1/ student |

## Special Notes on Materials:

Insects can be collected to identify later by putting them in vials of alcohol or hand sanitizer. The hand sanitizer works well because it does not spill. I prefer to collect them in clear plastic makeup cases. These work well because of the flat lids as opposed to the cylindrical vials. Here is a link from amazon.com with the type of [cases](https://www.amazon.com/Bekith-Clear-Plastic-Cosmetic-Containers/dp/B06XDT3RT8/ref%3Dsr_1_5?crid=3L138UMLMR4VR&keywords=makeup+plastic+containers+with+lids&qid=1559662049&s=gateway&sprefix=makeup+plastic%2Caps%2C167&sr=8-5) I am talking about. They come in many sizes.

My students collect with the butterfly nets and with hinged clear card cases. many students prefer the card cases. Here is a link from amazon.com with the type of [cases](https://www.amazon.com/gp/product/B00AEAGNVQ/ref%3Dppx_yo_dt_b_asin_image_o05_s02?ie=UTF8&psc=1) I am talking about.

**Lesson Procedures:**

1. Students collect arthropods in their butterfly nets and card cases. Students should disturb shrubs, grasses, and even move rocks and logs if possible. Arthropods usually go up when disturbed so nets and cases should be placed to anticipate this.
2. As each organism is caught, it needs to be placed in a case or vial of alcohol or hand sanitizer. These can then be identified at a later date. Students are also encouraged to take video of the insects moving to bring to their collaborative meetings with Engineering students. Preserved specimens can also be brought to these meetings.
3. Students are given the Arthropod Classification image (included in the Student Resources o the next page), the Arthropod Collecting Lab, and several insect identification books (such as Peterson’s Guides or Golden Guide). Students also found this [insect identification website](https://www.insectidentification.org/insect-key.asp) helpful.
4. Students identify the arthropods they have collected and record the data in their engineering notebooks.

# Student Resources:

* <https://www.insectidentification.org/insect-key.asp>
* [Arthropod Classification Image](https://www.dropbox.com/home/TRAILS%20Website_Official/Lesson%20Plans/Bug%20RV?preview=Arthropod+Classification+Image.pptx)
* [Arthropod Collecting Lab](https://www.dropbox.com/home/TRAILS%20Website_Official/Lesson%20Plans/Bug%20RV?preview=Arthropod+Collecting+Lab+2018.docx)

Lesson Plan 7: Insect Pavilions

# Lesson Focus:

Students designed and built structures “insect pavilions.” These are structures designed to encourage arthropods to live here. These structures allow elementary students to know of locations where they can find a variety of arthropods. Similar ideas can be viewed at <https://insteading.com/blog/insect-hotel/>.

# Total Time Required:

* 3 class periods. One class period is needed to brainstorming and design,one day is needed for construction, and one day is needed for collecting materials to go in the structures (such as grass, sticks, and pebbles). I spaced these activities several days apart to allow for students to bring in materials needed for construction.

# Lesson Objectives:

Students will be able to:

* Use the design process
* Design and build stable structures for insect habitats
* Apply knowledge about insects and their habitats

# Equipment and Materials

|  |  |
| --- | --- |
| Tools and Materials | Quantity Needed |
| Scrap lumber / pallets | amounts will vary widely with designs |
| Screws or nails | amounts will vary widely with designs |
| Power drill, hammer, screwdriver | amounts will vary widely with designs |
| Miscellaneous items: pottery, stickes, grasses, pinecones, pebbles... | amounts will vary widely with designs |
| Engineering Notebook | 1 / student |

## Special Notes on Materials:

The materials needed can vary widely. Students can bring in many of these items if they are given time. Some years we have used items like 2 liter bottles and other items of “trash” to build parts of these structures.

**Lesson Procedures:**

1. Students brainstorm ideas individually for insect pavilions. Each student will come up with 3 unique ideas. These will be recorded in their engineering Notebooks
2. Students will come together as cooperative groups to share ideas and develop one “best” idea.
3. Students will determine what materials are needed for their design.
4. At a later date (after materials are collected), students will assemble their pavilions. This may include drilling or cutting lumber. Having the cooperation from the shop area at you school is valuable.
5. Students go outside to collect natural items such as pine cones, grasses, sticks, and pebbles. These are placed in appropriate place in the pavilion.

# Student Resources:

No student Resources are needed.

Lesson Plan 8: 3D CAD modeling

# Lesson Focus:

Students will draw the “leaf cookies” using a 3D CAD modeling program.

 **Prior to this lesson, they must be taught the basics of 3D CAD modeling.**

# Total Time Required:

* Engineering students should be able to draw a leaf in 5 class periods of 45 minutes.

# Lesson Objectives:

Students will be able to:

* Sketch on the 3D CAD program
* Extrude the parts of the Bug RV
* Collaborate with group members to confirm accuracy of the drawing

# Equipment and Materials

|  |  |
| --- | --- |
| Tools and Materials | Quantity Needed |
| Engineering notebook with detailed dimensioned drawings of the BUg RV copied from Biology student | 1/ student |
| Computer with 3D CAD program | 1 / student |

## Special Notes on Materials:

Engineering students will need to collaborate with the Biology students about the Bug RV sketches. They must get all the information about the Bug RV and then sketch of the RV with very detailed dimensions. The collaboration must continue throughout the whole project. As drawings are done, the biology students must look over the 3D CAD drawings and approve them for accuracy.

**Lesson Procedures:**

1. Use the 3D CAD program to sketch the Bug RV with as much detail as possible.
2. Extrude the parts to no more than .125” thickness

# Student Resources:

Engineering notebook sketches

# Student Worksheets:

none

Lesson Plan 9: 3D Printing the Leaf

# Lesson Focus:

Saving the file as an STL file for slicing and 3D printing. After the 3D CAD drawing is approved and the students exports the file as an STL file the Bug RV needs to be printed. The teacher should slice the STL file with slicing software. Once sliced the Bug RV parts should be printed actual size as long as it fits on the printer. Use the 3D printing lesson for more details on printing the Bug RV.

# Total Time Required:

* One 45 minute class period

# Lesson Objectives:

Students will be able to:

* Save the 3D CAD file
* Export the 3D CAD file as an STL file
* Email the STL file to the teacher or save on a flashdrive
* 3D print the Bug RV parts

# Equipment and Materials

|  |  |
| --- | --- |
| Tools and Materials | Quantity Needed |
| Computer with 3D CAD software | 1 / student |
| Flash drive (if needed) | 1 / class |
| 3D printer | 1 or more / class  |

## Special Notes on Materials:

The teacher will be slicing the STL file to make a G-code of the Bug RV. Students may slice the file if allowed by the teacher. Use the 3D printing lesson to complete this lesson.

**Lesson Procedures:**

Follow the steps in the lesson on 3D printing

# Student Resources:

Student file of Bug RV

Student STL file

Slicing software

3D printer



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