Overview

To maximize the benefit of using PhET simulations (sims) in the classroom, activities sheets developed by the PhET team are designed with specific goals in mind.

Each activity is designed to be student-centered, providing opportunities for students to engage in inquiry, discuss their thoughts, and share ideas. The emphasis is on student sense-making through exploration of the sim, rather than heavily guiding students through the sim, which can lead to answer-making. In these activities, we strive for the sim to be the central focus. The activity sheet uses short prompts for guidance toward the learning goals and serves as a place to record thoughts and observations.

The activity sheet is developed to allow teachers to take advantage of teachable moments as they arise, to respond to students' discoveries, to allow for student collaboration, and to facilitate discussions. Activity sheets that are overly structured or include sim-related procedural instructions can stifle students' natural tendencies for sense-making and question-asking with the sim, and can prevent teachers from taking advantage of emergent teachable moments. Open, modular activities can avoid these issues, promoting student inquiry and allowing for customized facilitation.

Preparing to Develop an Activity Sheet

Select a Standard: For an upcoming topic, select a standard to teach in your class.

Choose a PhET Sim: Choose a PhET sim that focuses on the area of your chosen standard.

Identify Learning Objectives: With your chosen standard and the sim in mind, identify 2-3 specific learning objectives that support your chosen standard. The activity sheet you create will scaffold student learning and help students focus on these specific learning objectives. Too many learning objectives can lead to a lengthy and overly complex activity that is difficult to accomplish in one class period.

Tips for Developing Learning Objectives:
- Craft your learning objectives around specific aspects of the sim. It is not necessary to create learning objectives around all parts of the sim for a single activity sheet.
- You can use the same sim for multiple activities, with each activity addressing different but related learning objectives.
- Differentiated learning objectives can be supported by a sim.
- Choose learning goals that include specific, measurable, outcomes – e.g., students will be able to identify the variables that affect the strength of gravity, students will be able to describe how electrons move through working circuits. Avoid vague learning goals – e.g., students will understand gravity, students will know how circuits works).

Activity Sheet Design Guidelines

Some common attributes of activity sheets that can contribute to effective use of PhET sims are:

Take Advantage of Sim Features: Students are drawn to games or challenges in the sims. Design sections of the activity sheet to leverage games or challenges within the sim that relate to the activity's learning objectives. This strategy can prevent the activity sheet from competing with the sim for students' attention – e.g. requiring students to choose between what the sim encourages and what the activity sheet requires.

1-2 Pages in Length: Keep the activity sheet short – usually one page printed front and back. Short activity sheets allow opportunities for students and teachers to engage in meaningful sim exploration and discussion. Longer activity sheets can lead to a focus on 'getting through' the entire activity, and can limit opportunities to adapt the activity 'on the fly' to meet student needs.

Build in Time for Open Play: Start activities with about five minutes of open play, during which students explore any and all aspects of the sim without specific instructions. This open play time 1) decreases the need for sim-related procedural instructions in later parts of the activity, 2) maintains a sense-making mode of student learning rather than answer-making, 3) minimizes student distraction when working through the activity sheet and 4) supports student engagement and fun with the sim.

Minimal Wording: Short written prompts encourage students to view the activity sheet as a helpful tool to guide and organize their progress towards the learning objectives. Minimal wording also allows greater flexibility in facilitation. For second language learners, minimal wording decreases distracting sentences and allows the teacher to focus attention on specific terms and vocabulary.

Scaffold with Tables: Tables provide a framework for productive exploration without being overly prescriptive or overwhelming and are well-defined place for students to record responses to open ended questions. Effective use of tables structure sim use towards productive actions, which encourages inquiry-based learning, without requiring explicit directions. In addition, embedded checkboxes within tables allow for a quick check for understanding by the teacher.

Example Activity with Guideline Use Highlighted

Learning Objectives

First Name: _____ Last Name: _____ Class_____

Build a Molecule Computer Sim

Learning Goals:
1. Describe the difference between a molecule name and chemical formula.
2. Distinguish between the coefficient and subscript in a chemical formula.
3. Recognize how large molecules are broken into smaller molecules.

Minimal Wording

First Tab

Teacher Prompt: Open Play Time

1. Make molecules:
   a. How do you know you made a molecule? _____
   b. Write the molecule **name** of some molecules you made (ex. Water).

   _____   _____

   _____   _____

2. Molecule Names and Chemical Formulas:
   a. Compare the name and chemical formula for some molecules:

Molecule Name	Chemical Formula
_____	_____
_____	_____
_____	_____

Takes Advantage of Sim Features

Second Tab

Scaffolds with Tables

3. Make Many
   a. Fill all the collection boxes and then complete the questions for each Goal.

Goal: $3O_2$	
Draw it!	
What does the '3' in $3O_2$ mean?	
What does the '2' in $3O_2$ mean?	

Goal: $2NH_3$	
Draw it!	
What does the '2' in $2NH_3$ mean?	
What does the '3' in $2NH_3$ mean?	

Prompts and Tables

Prompts to Encourage Targeted Inquiry:

- **Find all the ways to**… make a complete circuit.
- **What's the largest**… molecule you can make?
- **How many**… collection boxes can you fill in 5 minutes?
- **List all the essential items to**…make a circuit.
- **What are two ways to**…get the sleepy dog to move?
- **How can you make**…the gravity force…**bigger**?
- **Develop a procedure for …** comparing the densities of two objects with different mass.

Effective Table Structures:

Cueing Variables: This structure cues students to make comparisons between variables.

Environment	Selection Factor	Mutation	Bunnies Take Over?	Bunnies Die Out?	Observations
			☐Yes ☐No	☐Yes ☐No	

Cueing Cause/Effect Relationships: This structure cues students to notice important effects of an action within the sim.

Action	Gravity Force
Put star and planet closer together	☐Increases ☐Decreases
	☐Increases ☐Decreases
	☐Increases ☐Decreases

Cueing Classification: This structure cues students to classify objects into distinct categories and is useful for organizing cause/effect relationships.

Good Conductors	Weak Conductors	Insulators
How can you tell something is a **good conductor** of electricity in the sim?	How can you tell something is a **weak conductor** of electricity in the sim?	How can you tell something is an **insulator** of electricity in the sim?

Cueing Conceptual Focus: This structure orients students to key conceptual aspects of the learning objectives. In the example below, students are cued to focus on balancing objects and recording results, rather than drawing unnecessary pictures of the sim.

Describe at least 2 different ways that you were able to balance the **objects with different masses** and draw them below.
1
2

Tips for Developing Tables:

- Create tables that include open space, rather than densely filled tables, by using minimal wording and providing room for written observations and/or actions.
- Cue student interactions with the sim, but avoid providing instructions for all interactions with the sim.
- Checkboxes provide quick checks for understanding that the teacher can make note of while facilitating.

Table Comparison – Dense vs. Open:

Dense Table: This table uses more words than necessary to result in the desired student comparisons, i.e. charge, not mass or element, changes upon addition of an electron. This table requires attention from the student to understand, which can distract from conceptual understanding and be interpreted as a form to fill out rather than a tool to assist understanding.

Type of Change	What else will this change? (Write YES or NO)
Add an electron	The element? _____ If so, how does it change? _____ The charge? _____ If so, how does it change? _____ The mass? _____ If so, how does it change? _____

Open Table: This table uses less words overall and provides more space for students write their observations. Using this – more open – table, students are cued to focus on exploration of the sim to respond to the prompts, and to use the table to make sense of their comparisons.

Action	What Changes?	How Does it Change?
Add an Electron	☐Element	
	☐Charge	
	☐Mass	